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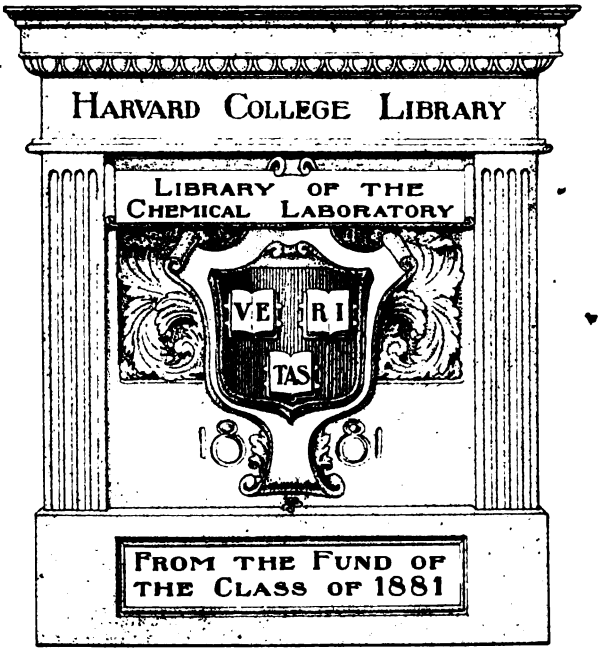


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## A Journal of Practical Chemistry

IN ALL ITS APPLICATIONS TO

## PHARMACY, ARTS, AND MANUFACTURES.

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*SIR WILLIAM CROOKES, D.Sc., F.R.S., &c.*

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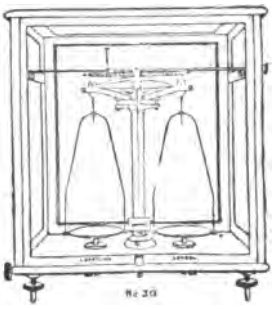

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# THE CHEMICAL NEWS.

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No. 2432.—JULY 6, 1906.

## NOTES OF A COURSE OF LECTURES ON THE OLD AND NEW CHEMISTRY.*

### I. Extracts from different Authors relating to the Old Chemistry.

By Prof. Sir JAMES DEWAR, F.R.S., &c.

### Chemical Prriods.

I.

It extends from the earliest period to the first centuries of the present era, and may be divided into three sections.

1. The history of chemical knowledge among the nations of antiquity down to the seventh century B.C. It includes what little is known of the chemical arts of the Indians, Egyptians, Hebrews, and other nations of antiquity. We can only judge of these from their metals, glass, colours, and other antiquities.

2. From 640 B.C. down to the second or third century A.D. It includes the arts of the Greeks and Romans, both as judged from their remains and from the allusions in their literature, and especially their speculations. The latter attract us by the names of Thales, Empedocles, Democritus, Leucippus, Aristotle, Lucretius, and a host of others. This is the epoch of the subjective evolution of natural laws.

3. This section coincides with the rise and progress of mysticism in the later Alexandrian schools. It is in this period that chemistry first appears as a branch of occult learning; and the germs of the idea which burst into full flower in the following period can be plainly traced in this.

II.

This corresponds to the Middle Ages of European history. Just as in the political events of this period the East and West were closely associated, a similar connection existed in science and literature. This, which is the period of alchemy, embraces the great names of Rhazes, Avicenna, Djabez (Geber), in the East, and the equally famous names of Albertus Magnus, Roger Bacon, Lully. and Basil Valentine in the West. It includes no fewer than seven centuries—from the eighth or ninth down to the sixteenth.

III.

At this time begins a new epoch, inaugurated by the zeal of Paracelsus—the epoch of medical chemistry. The theories of this time were of comparatively short duration. They dominated for barely two centuries, corresponding with the first two of modern history, after the Reformation. The chemists of this period were energetic and successful, and have left their names stamped deeply on the science. Besides Paracelsus were Libarius, Glauber, van Helmont, Agricola, and many others of great ability.

IV.

This falls within the seventeenth and eighteenth centuries, and it is the first in which chemistry stands out as a definite subject, with a special field of investigation apart from applications, with a body of ascertained facts and methods, and with what may be called a general principle.

It was inaugurated by Boyle, reached its highest theoretical position in Stahl, and was concluded amidst the brilliant discoveries of Black, Cavendish, Priestley, and Scheele.

V.

A single step with Lavoisier brings us to the last period, that of modern chemistry—a science of number, weight, and measure now raised to the rank of an exact science.

*Apocrypha (Wisdom of Solomon),*

"For the elements were changed in themselves by a kind of harmony, like as in a psaltery notes change the name of a tune and yet are always sound; which may well be perceived by the sight of the things that have been done."—(chap. xii.).

"The fire had power in the water forgetting his own virtue: and the water forgat his own quenching nature." "On the other side the flames wasted not the flesh of the corruptible living things, though they walked therein; neither melted they the icy kind of heavenly meat, that was of nature apt to melt. For he hath given me certain knowledge of the things that are, namely, to know how the world was made and the operations of the elements."—(chap. xix.).

*Ancient Egyptian Metallurgy—Rawlinson.*

"Metallurgy in Egypt comprises the working in gold, in silver, and lead to a small extent, in copper, in iron, and in bronze. Tin appears to have been scarcely used except as an alloy, while zinc was wholly unknown. The Egyptians found gold in considerable quantities within the limits of their own land. The manufacture of objects out of gold was effected by goldsmiths, who after melting down an ingot or a portion of one, in a crucible, with the help of a blow-pipe, proceeded to work the material into shape with the forceps and tongs, and finally to fashion it with graving tools. Among the objects produced the commonest were solid rings of a certain size and weight, which seem to have passed current as money, vases, bowls, baskets, armlets, bracelets, necklaces, ear-rings, and other ornaments of the person, cups, goblets, rhytons, and other

* Delivered at the Royal Institution, May 19th, 1906.

drinking vessels; statuettes also were sometimes made of gold, and figures of the sacred animals were inlaid with it.

"In silver the objects produced were principally rings used for money, vases, bracelets, plates to be employed as ornaments of mummies, figures of gods and sacred animals, and finger-rings. It is worthy of observation that the silver is sometimes gilt.

"Leaden objects seem scarcely to be found; and the only proof which exists of the metal being known and worked by the Egyptians is its employment as a solder in combination with tin, without which it will not serve the purpose; Egypt did not produce it, so far as appears, but it was sometimes taken as tribute from foreign nations in considerable quantities.

"It has been much questioned whether iron was employed at all by the Egyptians until the time of the Greek conquest, as but very few specimens of that metal have been found, and the date of the few iron objects discovered is very uncertain. The paucity of such instances is partially, if not wholly, accounted for by the rapid decay of iron in the nitrous earth of Egypt, or when oxidised by exposure to the air. It seems, moreover, very improbable that the Hebrews and Canaanites should for centuries have been well acquainted with the uses of iron, and their neighbours of Egypt, whose civilisation was far more advanced, have been ignorant of it.

"The manufacture of bronze was by far the most extensive branch of Egyptian metallurgy. The number of articles found of this alloy shows it must have been employed by the Egyptian metallurgists to as large an extent as all the other metals put together. The bronze was very variously composed, sometimes it contained as much as fourteen parts of tin and one of iron to eighty-five parts of copper, a very unusual proportion; more often the copper stood to the tin as eighty-five to twelve, while sometimes the proportion was as high as ninety-four to six.

"On a reference to the drawings found on the tombs in Egypt we find figures illustrating the arts of metallurgy and glass making, together with furnaces, blow-pipes, &c., but what is most interesting is that the operations were evidently conducted by weighed portions of matter, so that it is certain that the balance was employed at a very early period. We know, moreover, from Biblical history that the balance was used, for we read that 'Abraham *weighed* to Ephron the silver which he had named in the audience of the sons of Heth, 400 shekels of silver current with the merchant.'"

*Edict of Diocletian against Alchemy*, A.D. 284—306.*
(Gibbon's "Decline and Fall," Chap. xiii.)

"'He caused a diligent enquiry to be made for all the ancient books which treated of the admirable art of making gold and silver, and without pity committed them to the flames; apprehensive as we are assured, lest the opulence of the Egyptians should inspire them with confidence to rebel against the empire.' But if Diocletian had been convinced of the reality of that valuable art, far from extinguishing the memory, he would have converted the operation of it to the benefit of the public revenue. It is much more likely that his good sense discovered to him the folly of such magnificent pretensions, and that he was anxious of preserving the reasons and fortunes of his subjects from the mischievous pursuit. It may be remarked that these ancient books, so liberally ascribed to Pythagoras, Solomon, or Hermes, were the pious frauds of more recent adepts. *The Greeks were inattentive either to the use or to the abuse of chymistry.* In that immense register, where Pliny has deposited the discoveries, the arts, and the errors of mankind, there is not the least mention of the transmutation of metals, and the persecution of Diocletian is the first authentic event in the history of alchemy. The conquest of Egypt by the Arabs diffused that vain science over the Globe."

* Diocletian (Diocletianus Valerius) was elected to the purple after the assassination of Numerianus, A.D. 284; he besieged Alexandria and defeated and subdued the Egyptians.

*Metals of the Ancient Greeks discovered in the Excavations at Troy, Mycenæ, &c., by Dr. Schliemann.*

"Together with thousands of stone implements, I found also many of copper, and the frequently discovered moulds of mica-schist for casting copper weapons and implements, as well as the many small crucibles, and small roughly made bowls, spoons, and funnels for filling the moulds, prove that this metal was much used.

"We find copper vessels continually referred to in the Iliad, together with tripods, as prizes in the games, or as presents. But they are generally referred to in the Odyssey as basins in which the hands were washed at the sacrifice or before dinner. They were also used for the foot-bath. It deserves particular attention that three of the five copper vessels, and particularly the large can, show unequivocal marks of long use on the fire, also that there is no soldering in any one of the large copper vessels found in this or any other of the Mycenean tombs; these large vessels consist merely of copper plates, solidly joined together with innumerable small pins. All the handles are likewise attached with broad-headed nails.

"While speaking of soldering, I may mention that Prof. Landerer informs me that the Mycenean goldsmiths soldered gold with the help of borax (borate of soda), which is still used for the same purpose. He adds that he was lucky enough to discover this salt on the border of an ancient false medal from Ægina; that it was called in antiquity 'gold cement,' and that it was imported from Persia and India."

*Pliny's View of some Marvellous Facts connected with Fire.*

"Having now described all the creations of human ingenuity, reproductions, in fact, of nature by the agency of art, it cannot but recur to us with a feeling of admiration, that there is hardly any process which is not perfected through the intervention of fire. Submit to its action some sandy soil, and in one place it will yield glass, in another silver, in another minium, and in others again lead and its several varieties, pigments, and numerous medicaments. It is through the agency of fire that stones are melted into copper; by fire that iron is produced, and subdued to our purposes; by fire that gold is purified; by fire, too, that the stone is calcined which is to hold together the walls of our houses. Some materials, again, are all the better for being repeatedly submitted to the action of fire; and the same substance will yield one product at the first fusion, another at the second, and another at the third. Charcoal, when it has passed through fire and has been quenched, only begins to assume its active properties; and when it might be supposed to have been reduced to annihilation it is then that it has its greatest energies,

"An element this, of immense of boundless power, and as to which it is a matter of doubt whether it does not create even more than it destroys."

*Ordeal by Fire.*

One of the Pontiffs of the religion of Zoroaster, Adurabad Mabrasphand, offered to submit to the proof of fire. He proposed that they should throw over his body a quantity of molten copper at a white heat, prophesying that it should not burn him. The incredulous regarded the experiment as prodigious. It is said the trial was made with success, and that many converts were made.

*Origin of Symbols of the Metals.—Beckman.*

"The next question is, Why were the metals divided in the like manner among the gods, and named after them? Of all the conjectures that can be formed in answer to this question, the following appears to me the most probable.

"The number of the deified places made the number seven so sacred to the Egyptians, Persians, and other nations, that all those things which amounted to the same number, or which could be divided by it without a remainder, were supposed to have an affinity or a likeness to, and connection with each other. The seven metals, therefore, were considered as having some relationship to

the planets, and with them to the gods, and were accordingly named after them.

"To each god was assigned a metal, the origin and use of which was under his particular providence and government; and to each metal were ascribed the powers and properties of the planet and divinity of the like name: from which arose, in the course of time, many of the ridiculous conceits of the alchemists. In the character ☿ the adepts discover gold with a silver colour.

"The mythological signification of these characters cannot be older than the Grecian mythology, but the chemical may be traced to a much earlier period."

*Magic.—Ennemoser.*

The term magic has come down to us from very early times, and always in close association with the priesthood. By an easy gradation we get the term magi applied to men who, while exercising the functions of the Priest, applied themselves to the acquisition of secular knowledge of all kinds.

The Magi are to be met with in the most ancient traditions of the old world. India, Persia, Chaldea, and Egypt were the cradles of the oldest magic; Zoroaster, Ostanes, the Brahmins, the Chaldean sages, and the Egyptian priests were the primitive possessors of its secrets. It must be admitted their knowledge was used to the furtherance of human happiness; justice, truth, and the power of self-sacrifice being the qualities with which they are endowed; the neglect of any one of these virtues was punished in the most cruel manner. From Pliny we learn that magic was early associated with medicine, though the common belief was that it included all occult science; later under this title was understood enchantment and any extraordinary operations, such as making gold, exorcising spirits, &c.

Among the supernatural powers was reckoned that of predicting the future, and that of acting directly upon others even at a distance; and on this account magic may be separated into seeing and acting. The original description was, in fact, grounded on this aphorism: "Man may become, by this assistance and co-operation of spiritual powers, and the capacities of his higher divine origin, capable of a higher sphere of activity as well without as within himself, which gives him dominion over his own, and over surrounding nations."

We have no immediate and authentic source to which we may refer for the myths and mysteries of the ancient nations. Among the Egyptians and Orientals, we find but fragments, though in such numbers that we are able to decide that it is among the nations of the East that we must search for earlier traces, and even for their origin. According to the latest investigations, the very earliest records are to be met with in the Zendavesta, the Laws of Manu, and the Jewish Traditions of the Cabbala. Of the latter it is interesting to take a nearer view, and examine some of its principal teachings which are not alone of importance to theology, but to philosophy in general, and magic in particular. Inquiries instituted in our own time have shown, at all events, that the traditions of Judaism belong to the earliest sources of the mysteries. Schelling suggests that in the Grecian mythology the ruins of a superior intelligence and even a perfect system are to be found, and further, that possibly some portions of the system might be discovered in the Jewish philosophy, or the so-called Cabbala. Many references to this Hebrew source may be traced in early writers; indeed, the greater part of the writings of the Middle Ages were probably but continuations of that which had already been borrowed from the Cabbala, although Johannes Scotus Erigena, Albertus Magnus, Raymond Lully, and others appear to have prosecuted individual inquiries. Later we find many inquirers in this fruitful field of research. The philosophies of Agrippa, of Paracelsus, of Van Helmont, and Jacob Bœhmen, all bear striking resemblance to the Jewish teachings. Of this latter, a recent writer made this startling assertion, that "in Bœhmen's writings is to be found the true and clear demonstration of every physical fact that has been discovered since his day."

According to the Cabbala, there exists, besides angels, intermediate spirits—the spirits of the elements—the *Schedim* of the Jews, and divided into four classes, the chief of whom is Asmodi. The first class contains the spirits of the fire; the second of fire and water; the third of fire, air, and water; the fourth have a mineral ingredient. This is completely the doctrine of Paracelsus. The spirits of the two last classes are possessed mostly of evil natures, and are fond of causing injury to man. The other two are possessed of greater wisdom, and knowing many of the secrets of nature, willingly disclose them to man. According to the Cabbala, everything that exists, whether great or small, stands in a magical union with the rest of nature. Everywhere is the external the operation of the internal, and the external reacts upon the internal; thus the stars have as great an influence upon man as upon the whole of nature; for the constellations presiding at the birth of a child determine its physical and mental qualities. These extracts are sufficient to give an idea of the contents of the Cabbala with regard to magic, which it treats of in all its ramifications, containing that which became Christian mysticism, and the magic of the Middle Ages.

*Transmutation of Metals and Astrology.—Godwin.*

"In proportion as the pursuit of transmutation and the search after the elixir of immortality grew into vogue, the adepts became desirous of investing them with the venerable garb of antiquity. They endeavoured to carry up the study to the time of Solomon; and there were not wanting some who imputed it to the first father of mankind. They were desirous to track its footsteps in ancient Egypt, and they found a mythological representation of it in the expedition of Jason after the Golden Fleece, and in the caldron by which Medea restored the father of Jason to his original youth. But, as has already been said, the first unquestionable mention of the subject is to be referred to the time of Diocletian.

"The art, as we have said, is in its own nature sufficiently mystical, depending on nice combinations and proportions of ingredients, and upon the addition of each ingredient being made exactly in the critical moment, and in the precise degree of heat, indicated by the colour of the vapour arising from the crucible or retort. This was watched by the operator with inexhaustible patience; and it was often found or supposed that the minutest error in this respect caused the most promising appearances to fail of the expected success. This circumstance, no doubt, occasionally gave an opportunity to an artful impostor to account for his own miscarriage and thus to prevail upon his credulous dupe to enable him to begin his tedious experiment again.

"But besides this, it appears that those whose object was the transmutation of metals very frequently joined in this pursuit the study of astrology, and even the practice of sorcery. So much delicacy and nicety were supposed to be required in the process for the transmutation of metals, that it could not hope to succeed but under a favourable conjunction of the planets; and the most flourishing pretenders to the art boasted that they had also a familiar intercourse with certain spirits of supernatural power, which assisted them in their undertakings, and enabled them to penetrate into things undiscoverable to mere human sagacity and to predict future events."

"The supposed science of astrology is well worthy of attention, if for no other reason, because it has prevailed in almost all nations and ages of the world, and has been assiduously cultivated by men frequently of great talent, and who were otherwise distinguished for the soundness of their reasoning powers, and for the steadiness and perseverance of their application to the pursuits in which they engaged. The whole of the question was built upon the supposed necessary connection of certain aspects and conjunctions or oppositions of the stars and heavenly bodies,

with the events of the world and the characters and actions of men. The human mind has ever confessed an anxiety to pry into the future, and to deal in omens and prophetic suggestions, and, certain coincidences having occurred, however fortuitously, to deduce from them rules and maxims upon which to build an anticipation of things to come. The general belief in astrology had a memorable effect on the history of the human mind. Men, so far as they are believers in astrology, look to the stars, and not to themselves, for an account of what they shall do, and resign themselves to the omnipotence of a fate which they feel it in vain to resist. Of consequence a belief in astrology has the most unfavourable tendency as to the morality of man; and, were it not that the sense of the liberty of our actions is so strong that all the reasonings in the world cannot subvert it, there would be a fatal close to all human dignity and all human virtue."

*The Elements of the Alchemists and Alchemy.—Liebig.*

"In the spirit of the earlier philosophy which ascribed all causes of action not perceptible by the senses to invisible spirits, and all sensible properties to tangible and material causes, common sulphur and quicksilver were regarded at first as actual constituents of the metals; certain properties were believed to be dependent on their presence, exactly as, at a more recent period, the causticity of lime and the alkalies was ascribed to the causticum or caustic principle, the peculiar smell of certain bodies to the spiritus rector, and the acidity of the acids to a primitive or original acid."

"In the ideas of the alchemists, actual sulphur and mercury were gradually supplanted by an ideal sulphur and an ideal mercury; things which combined in themselves a certain number of properties. These ideal bodies, at a later period, took the form of elementary qualities. Many bodies possessed the property of being volatile, without alteration in their other properties, when exposed to fire.

"They were sublimable, like arsenic, or capable of being distilled, like mercury. Another class of bodies was also volatile, but underwent a change in the fire, such as sulphur. A third class, although changed in the fire, was not volatile, but fixed, like the salts found in ashes. Sulphur, mercury (arsenic), and salt became at last, as has been stated, abstract conceptions, simple elements, in the sense of the four elements of Aristotle.

"As we speak of the form and shape of a thought, without understanding by these figurative terms a bodily shape, so did men in those days express abstract notions by terms indicating bodily or material things, without understanding thereby anything more than properties."

"The chemical elements of the early philosophers could not, it is obvious, be obtained in a separate form, because they were merely terms, denoting qualities alone. No one thought of obtaining them: they were regarded as constituents of all bodies."

"In order to attain that knowledge of chemistry which we now possess, it was necessary that thousands of men, armed with all the science of their respective periods, and inspired with an unconquerable ardour, with a passion for knowledge, which in its violence bordered on madness, should devote life, fortune, and their whole faculties, to the task of exploring the earth in all directions.

"It was necessary that, with indefatigable perseverance and constancy, these men should bring into contact all known substances, organic and inorganic; it was necessary that these labours should be continued for fifteen centuries. There was, finally, a mighty, an irresistible charm which urged men to devote themselves with an amount of patience and perseverance altogether unexampled in history to labours which did not tend to supply any want peculiar to the time in which they lived. This mighty impulse was nothing else than the desire for earthly happiness. By a wonderful and wise dispensation there was implanted in the minds of the wisest and most experienced men the idea of the existence of a thing, hid in the bowels of the earth, by he discovery of which man might become possessed of those things which imply the gratification of the utmost desires of a refined sensuality—namely, gold, health, and long life, 'Gold gives power; without health there is no enjoyment, and longevity here takes the place of immortality.'—*Göthe.*

"It is the prevailing ignorance of chemistry, and especially of its history, which is the source of the very ludicrous and excessive estimation of ourselves, with which many look back on the age of alchemy; as if it were possible, or even conceivable, that for more than a thousand years the most learned and acute men, such as Francis Bacon, Spinoza, and Leibnitz, could have regarded as true and well founded an opinion void of all foundation. On the contrary, must we not suppose, as a matter beyond a doubt, that the idea of the transmutability of metals stood in a most perfect harmony with all the observations, and all the knowledge of that age, and in contradiction to none of these?

"In the first stage of the development of science, the alchemists could not possibly have any other notions of the nature of metals than those which they actually held. No others were admissible or even possible; and their views were consequently, by natural law, inevitable. Without these ideas chemistry could not now stand in its present perfection; and in order to call that science into existence, and in the course of 1500 or 2000 years to bring it to the point which it has now reached, it would have been necessary to create the science anew.

"We hear it said that the idea of the philosopher's stone was an error; but all our views have been developed from errors, and that which to-day we regard as truth in chemistry may, perhaps, before to-morrow, be regarded as a fallacy. Every theory which urges men to labour and research, which excites acuteness and sustains perseverance, is a gain to science; for it is labour and research which lead to discoveries.

"Alchemy was never at any time anything different from chemistry.

"It is utterly unjust to confound it, as is generally done, with the gold-making of the sixteenth and seventeenth centuries. Among the alchemists there was always to be found a nucleus of genuine philosophers who often deceived themselves in their theoretical views; whereas the gold-makers properly so called knowingly deceived both themselves and others.

"Alchemy was the pure science, gold-making included all those processes in which chemistry was technically applied. The achievements of such alchemists as Glauber, Böttger, and Kunkel, in this direction, may be boldly compared to the greatest discoveries of our century.

"But to return to alchemy. In judging of it we are but too apt to forget that a science represents a spiritual organism, in which, as in man, self-consciousness first appears at a certain stage of its development. We now perceive that all the special objects pursued by the alchemists have contributed to the attainment of a higher end than that of which they were conscious. The path which has led to this result was obviously the best.

"To build a palace, we require many stones, which must be quarried, and many trees which must be felled and hewed; but the plan comes from above, and is known to the architect alone.

"The philosopher's stone, for which the ancients sought with a dim and ill-defined impulse, was in its perfection nothing else than science of chemistry.

"Is that not the philosopher's stone which promises to increase the fertility of our fields and to insure the prosperity of additional millions of mankind? Does not chemistry promise that, instead of seven grains, we shall be enabled to raise eight or more on the same soil?

"Is that science not the philosopher's stone which changes the ingredients of the crust of the earth into useful products, to be further transformed by commerce into gold?

"Is that knowledge not the philosopher's stone which promises to disclose to us the laws of life, and which must

finally yield to us the means of curing diseases and of prolonging life?

"Every new discovery opens up wider and richer fields to our researches; and in the laws of nature we are still ever seeking the 'virgin earth' of the alchemists, a search which can never have an end."

(To be continued).

## ON THE OSMOTIC PRESSURES OF SOME CONCENTRATED AQUEOUS SOLUTIONS.*

By the Earl of BERKELEY and E. G. J. HARTLEY.

THIS communication gives an account of measurements of osmotic pressures of aqueous solutions of cane-sugar, dextrose, galactose, and mannite. The method adopted is that briefly outlined by us in *Proc. Roy. Soc.*, vol. lxxiii. A gradually increasing pressure is placed upon the solution (which is separated from the solvent by a semi-permeable membrane) until the solvent, which at first flows into the solution, reverses its direction, and is squeezed out. The pressure, when there is no movement of the solvent, is considered to be the osmotic pressure. Owing to the difficulty of determining the exact point at which no movement takes place and for other reasons, the experiments are carried out so as to enable an observation to be made of the rate of movement of the solvent, both when the pressure on the solution is just below and when just above the turning point pressure. The osmotic pressure is deduced from these rates.

The range of pressures covered by the experiments is from 12 to 135 atmospheres.

A description is also given of the methods adopted for making the copper ferrocyanide membranes, and it is pointed out that with the best membranes, in most cases, a small quantity of solution comes through during the experiment. It is shown that even a small leak causes a considerable lowering of the observed pressure; hence the final results accepted are those where the leak was least.

Attention is drawn to the fact that the osmotic pressures of cane-sugar solutions when measured directly and when calculated from their vapour pressures agree to within 3 per cent.

## ELECTRO-CHEMICAL CALCULATIONS.†.

By JOSEPH W. RICHARDS.

ELECTRO-CHEMICAL processes produce chemical changes through the agency of the electric current, and the current is used primarily either for its electrolytic effect or for its thermal effect. The first thing needful, in order to make any calculations connecting electric energy with thermal or chemical effect, is to set forth the values of electric energy as expressed in thermal or mechanical units, in order to get a common energy basis on which to make comparisons, and to postulate the facts concerning the electrolytic effect of the electric current.

### ENERGETICS OF THE ELECTRIC CURRENT.

One watt-second of electric energy may be postulated as equivalent to one joule of mechanical work, or 0·2385 grm.-calories. This is the energy basis on which electric and chemical phenomena meet on common ground, for the only energy measure of chemical reaction which has as yet been quantitatively investigated is the thermal one. We therefore express the energy of a chemical reaction in the terms in which that energy has been measured, and then have the theoretical bases for calculating the amount of electrical current which can theoretically furnish that amount of thermal energy.

### PRINCIPLES OF THERMO-CHEMISTRY.

The measuring of the amount of heat liberated or absorbed in chemical combination or decomposition or reaction is the province of thermo-chemistry. Many enthusiastic scientists have accumulated large numbers of these experimental data, from which, however, very few generalisations have been, up to the present, deduced. There are critical discussions of thermo-chemical data for inorganic compounds in Ostwald's "Allgemeine Chemie"; one can find the most complete collection of thermo-chemical figures yet published, both for inorganic and organic compounds, in Berthelot's "Thermochemie"; in English, Muir's "Elements of Thermal Chemistry" is the only collection of tables on this subject which aims at completeness, and the work is at present nearly two decades old. More or less incomplete or fragmentary tables can be found in works on chemistry or treatises on heat. In giving the data, chemists always give the heat change for molecular weights of the substances concerned; for instance, $(H_2,O) = 69{,}000$ calories means that when two parts of hydrogen unite with sixteen parts of oxygen to form eighteen parts of water, 69,000 heat units are evolved. If the weights of the substances be called kilogrms., the heat units are kilogrm.-calories; if called grms. they are grm.-calories; if called ounces or pounds, they are ounce- or pound-calories (1° C.). The Germans write the above $(H_2,O = 690$ K, in which K stands for 100 ordinary heat units, while the French write it $(H_2,O) = 69{\cdot}0$ cal., in which the weights of the substances are supposed to be taken in *grms.*, and the heat evolved expressed in *kilogrm.*-calories. In our opinion, the English style first given is logically and practically superior to the other two, and is the best to follow.

It must be borne in mind that, almost without exception, the thermo-chemical data given in the tables are those which have been determined starting with the constituents at laboratory temperature and ending with the products at the same, or very nearly the same, temperature. The heat quantities therefore apply strictly only to electro-chemical processes taking place at ordinary temperature, or very near thereto, and with the constituents or products in the same physical state as was used in the calorimetric determination. If the electro-chemical process is taking place at any different temperature, let us call it $t°$ C., and the ordinary temperature 15° C., the heat of the chemical change at $t°$, from constituents at $t°$ to products at $t°$, or *vice versâ*, can be calculated from the rather simple rule, that:—

*The heat of combination at* t° *equals the heat of combination at* 15° (*tabulated heat*), *plus the heat necessary to raise the constituents from their ordinary state at* 15° *to their ordinary state at* t°, *and minus the heat which would be necessary to raise the products from their ordinary state at* 15° *to their ordinary state at* t°.

The above calculation requires a knowledge of the specific heats and latent heats of change of state of the constituents and of the products of the reaction, between 15° and $t°$, but when these are known, the heat of the reaction at $t°$, the quantities very often needed in electro-chemical calculations, can be evaluated. These specific heats and latent heats are best obtained from such standard works as Landolt and Bornstein's "Physikalische-chemische Tabellen," or works of similar scope in English.

### FARADAY'S LAWS.

There is another and an entirely different quantitative relation between the amount of electric current used and the quantity of electro-chemical action produced, which applies to direct current producing electrolysis. In this case, while the energy relations hold, yet they are conditioned by the fact that every coulomb of electricity passing produces a definite amount of chemical change, equivalent to the setting free of a certain weight of hydrogen, for instance, and the energy required must adjust itself to the bringing about of this amount of chemical change. I am referring, of course, to Faraday's

* Abstract of a Paper read before the Royal Society, June 7, 1906.
† From the *Journal Franklin Institute*, February and March, 1906.

discoveries, which may be briefly summed up in the two statements that :—

1. The amount of chemical change produced electrolytically by the current is proportional only to the amount of electricity passing, as measured in coulombs, and is independent of the strength or temperature of the electrolyte, or the size or distance apart of the electrodes.
2. The amount of different elements dissolved or set free by the passage of a given amount of electricity proportional to their chemical equivalents.

When it was determined experimentally that 0·00001035 grm. of hydrogen is set free by one coulomb, or that 96,540 coulombs set free one chemical equivalent, 1 grm., of hydrogen, the whole scale of relations for all elements whose chemical equivalents were known, became known. The "*Faraday*," 96,540 coulombs, sets free, or tends to set free, in passing from an anode to a cathode, a chemical equivalent weight in grms. of any element. No law of nature has been subjected to more rigorous tests than this law of Faraday, and it appears so far as a law without an exception.

### Evolution of Gas Electrolytically.

A Faraday of current 96,540 coulombs (representing 26·82 ampère hours) sets free 1 grm. equivalent of metal or acid element or radical. If the element or acid radical is gaseous, there is a simple relation between the current flow and the volume of gas evolved, based on the observation that a grm. equivalent of a monatomic gaseous element has a volume under standard conditions of temperature and pressure of 22·22 litres, of a diatomic gaseous element, of 11·11 litres, &c. Thus, 96,540 coulombs set free a grm. equivalent weight of hydrogen, chlorine, sodium, zinc, &c. The formulæ for these in the gaseous state are Na, Zn, $H_2$, $Cl_2$; the molecules of these gases, representing 22·22 litres, contains therefore :—

| | | | | |
|---|---|---|---|---|
| Na | molecule | —1 | grm.-equivalents | |
| Zn | " | —2 | " | " |
| $H_2$ | " | —2 | " | " |
| $Cl_2$ | " | —2 | " | " |
| $O_2$ | " | —4 | " | " |

Therefore, 1 Faraday (26·82 ampère hours) sets free 1 grm. molecule of sodium vapour (22·22 litres), and ½ a grm. molecule (11·11 litres) of vapour of zinc, hydrogen gas or chlorine gas, assumed at normal temperature and pressure. For any other temperature, $t$, or pressure, $p$, in m.m. of mercury, the volume would be :—

$$\text{Standard volume} \times \frac{273 + t}{273} \times \frac{760}{p}.$$

*Example.*—How much oxygen and hydrogen should be produced per day by 300 ampères passing through 20 cells in series?

*Solution.*—The ampère hours performing electrolysis are—

$$300 \times 20 \times 24 = 144{,}000.$$

The Faradays' passing are—

$$144{,}000 \div 26{\cdot}82 = 5370.$$

The volumes of gas produced will therefore be—

$$5370 \times 11{\cdot}11 = 59{,}670 \text{ litres of hydrogen.}$$
$$5370 \times 5{\cdot}55 = 29{,}835 \text{ litres of oxygen.}$$

If the gas evolved is a compound gas or acid radical, which is formed at the electrodes, the valence of the acid of basic constituent in a molecule of the gas is the basis of calculation. For instance, CO, $CO_2$, $CH_4$, $H_2S$ all represent molecules of the said gases, of a volume of 22·22 litres, and contain respectively :—

| | | | | | |
|---|---|---|---|---|---|
| CO | contains | 2 | grm.-equivalents | of | oxygen |
| $CO_2$ | " | 4 | " | " | " " |
| $CH_4$ | " | 4 | " | " | " hydrogen |
| $H_2S$ | " | 2 | " | " | " " |

One Faraday (26·82 ampère hours) which would produce 1 grm.-equivalent of oxygen or hydrogen, would therefore produce half a molecule (11·11 litres) of CO or $H_2S$, or quarter of a molecule of $CO_2$ or $CH_4$ (5·55 litres).

Another means of calculating the volume of these gases is to note that $CO_2$ and $H_2S$ are equal in volume to the oxygen or hydrogen contained in them, CO is double the volume of the oxygen contained in it, and $CH_4$ is double the volume of the hydrogen going into its composition; so that the volumes of the compound gases can be calculated from the volumes of the simple gases going into their formation. The relations alluded to are shown by the Roman numerals indicating molecules or volumes in the following equations:

$$\overset{\text{I.}}{O_2} + 2C = \overset{\text{II.}}{2CO}$$
$$\overset{\text{I.}}{O_2} + C = \overset{\text{I.}}{CO_2}$$
$$\overset{\text{II.}}{2H_2} + C = \overset{\text{I.}}{CH_4}$$
$$\overset{\text{I.}}{H_2} + S = \overset{\text{I.}}{H_2S}$$

### Ohm's Laws.

The resistance which the electric current encounters to its flow through the body of a substance is determined by the specific resistivity of the body per unit cube of substance, multiplied by its length and divided by its cross-sectional area. The specific resistivity is given in tables per centimetre cubed, in ohms, and the simple arithmetic described gives us the resistance of any bar or wire of said material. The resistance of the body being known, Ohm's laws furnish us with the relation between the applied voltage and current flow through the body as follows :—

$$\text{Current} = \frac{\text{potential drop}}{\text{resistance}},$$

or—

$$\text{Ampères} = \frac{\text{volts drop}}{\text{ohms resistance}}.$$

These relations apply to the current *in the body* of an electrolyte just as strictly as to a metallic wire (and tables of specific resistivity of electrolytes are given in almost all books on electro-chemistry), but they do not apply at all to the resistance or drop of potential at the surface of an electrode; that is, at the contact surface where current enters or leaves an electrolyte. (Kohlrausch and Holborn's "Leitungsfähigkeit der Elektrolyte" is the most complete collection of such data). That latter potential drop is due to chemical work being performed, and has no connection whatever with ordinary ohmic resistance and Ohm's laws.

### Resistance Capacity of Vessels.

In making electro-chemical experiments, as in tubes or in vessels between fixed electrodes, it is often convenient to calculate, as a constant of the apparatus, the "resistance capacity" of the vessel. This is simply its ohmic resistance, between the two fixed electrodes, supposing it to be filled with a liquid whose specific resistance is unity. If the cross section is uniform, and the electrodes of similar area, this resistance capacity would be in ohms, supposing the measurements made in centimetres :—

$$\text{Resistance capacity} = \frac{\text{length between electrodes}}{\text{cross sectional area of electrolyte}}.$$

Thenceforth, if said vessel is filled between the electrodes with a liquid whose specific resistance is known, the ohmic resistance of the electrolyte will be simply the product of the resistance capacity by the specific resistance of the given liquid used; that is, ohmic resistance of electrolyte = resistance capacity of the vessel × specific resistance of electrolyte.

DETERMINATION OF OHMIC RESISTANCE.

If the conductor is not electrolysed by the current, its resistance is measured by sending a known current through it and measuring the drop of potential at its terminals.

$$\text{Resistance (in ohms)} = \frac{\text{potential drop (in volts)}}{\text{current flowing (in ampères)}}.$$

The current used may be either direct or alternating, the former is preferable because of the more accurate measurements possible. Another method, not so often used, but applicable under many circumstances, is to put a delicate thermometer or thermo-couple in contact with the conductor and measure the rate at which its temperature *begins* to rise. Knowing its specific gravity (weight of 1 c.c. in grms.) and its specific heat (per unit of weight), the heat generated per second in 1 c.c. is known :—

Heat generated (grm. calories = specific gravity × specific heat × rise of temperature per second.

But this quantity is also equal to the heat value of the current used, which is 0·2385 times the watts used, or 0·2385 times the square of the current used into the resistance. We therefore have :—

$$\text{Resistance (in ohms)} = \frac{\text{heat found calorimetrically}}{0{\cdot}2385 \times (\text{current used})^2}.$$

The above method is particularly applicable to electrolytes of any kind if they are placed in a long tube of low heat-conducting material, and the rise of temperature thus measured at a point remote from the electrodes. Then, whatever action, chemical or thermal, occur at the electrodes, and whatever potential drop may occur, it is only necessary that the amount of current passing be accurately measured, the specific heat and specific gravity of the electrolyte be known, and the rate of rise of temperature be measured at the first few seconds after turning on the current, to be able to calculate the specific resistance.

The use of alternating current for measurements of ohmic resistance using Kohlrausch's method of Wheatstone bridge and a telephone is applicable with accuracy to non-electrolytic conductors, and has generally been assumed to be applicable quite as accurately to electrolytes. Recent work on the possibility of electrolysis occurring when alternating current is passed through an electrolyte has rather cast doubts upon the accuracy of these tests. It is possible that most determinations thus made have been free from error, but we can understand now that tests so made might be erroneous in many instances, if made with certain electrodes and with certain frequency of alternation of the measuring current.

For many practical purposes, the ohmic resistance of an electrolytic cell can be determined by the following simple device and calculation :—Use electrodes equal to the cross section of the electrolyte, and put in series with a relatively high resistance, so as to keep the strength of current as nearly constant as possible. Measure ampères and voltage drop with the plates as wide apart as possible; draw together till they are exactly half the distance apart, and measure again. If the outside resistance is high enough, the ampères will be constant within the ability of the ammeter to record, while the voltage will decrease. Double the decrease in voltage will be the total voltage drop in overcoming the ohmic resistance of the whole cell. Designating this as the voltage drop due to electrical conductivity of the electrolyte, $V^c$, we have :—

$$\text{Resistance of cell (in ohms)} = \frac{V^c}{\text{ampères passing}}.$$

(To be continued).

Rapidity of Absorption of Odours by Milk.—F. Bordas and M. Toutplain.—The authors perform a series of experiments on the rapidity of absorption of formic aldehyde vapours by milk.—*Comptes Rendus*, cxlii., No. 22.

# PROCEEDINGS OF SOCIETIES.

## CHEMICAL SOCIETY.

*Ordinary Meeting, June 21st, 1906.*

Prof. R. MELDOLA, F.R.S., President, in the Chair.

PROF. T. E. THORPE, F.R.S., delivered the Cleve Memorial Lecture. A vote of thanks to the lecturer was proposed by Sir HENRY E. ROSCOE, seconded by Prof. TILDEN, and carried by acclamation.

The PRESIDENT announced that the Council had awarded the Longstaff medal to Prof. W. N. Hartley, F.R.S., in recognition of his spectrochemical investigations; the presentation will be made at the first meeting of the new session, Thursday, October 18th, at 8.30 p.m.

Messrs. H. G. F. Micklewright and J. S. Hills were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Samuel Field, 53, Whitburn Road, Lewisham, S.E.; Frederick James Harris, 1, Alexandra Terrace, Bath Road, Exeter; Archibald McArthur Johnston, Box 108, Germiston, Transvaal, South Africa; Emmanuel Isaac Thorne, 13, Cantwell Road, Plumstead, S.E.; Frederick William Watson, B.Sc., P.O. Box 108, Germiston, Transvaal, South Africa.

A certificate has been authorised by the Council for presentation for ballot under By-law I. (3) in favour of Dr. Charles H. Hertz, Chapel Hill, North Carolina, U.S.A.

Of the following papers, those marked * were read :—

*124. "*The Constituents of the Essential Oil from the Fruit of* Pittosporum undulatum." By FREDERICK BELDING POWER and FRANK TUTIN.

The oil employed in this investigation was freshly distilled for the purpose in Australia. From 220 kilogrms. of the nearly ripe fruit, gathered during December and January, 960 grms. of oil were obtained, corresponding to a yield of 0·44 per cent. The essential oil is pale yellow, and has a pleasant odour resembling that of orange oil. Its constants were as follows :— $d_{15°/15°} = 0{\cdot}8615$; $\alpha_D +74° 4'$ in a 1-dcm. tube. It was insoluble in ten times its volume of 70 per cent alcohol.

The results of the investigation have shown that Pittosporum oil contains the following substances :— *d*-Pinene (nitrosochloride, nitrolbenzylamine, m. p. 123°), about 4 per cent; *d*-limonene (tetrabromide, m. p. 104°), about 75 per cent; esters of valeric, formic, and other acids, a small amount; an optically inactive *sesquiterpene* (b. p. 263—264°, corr.; $d_{15°/15°} = 0{\cdot}9100$; $n_D\ 20° = 1{\cdot}5030$; molecular refraction, 66·22), about 15 per cent; palmitic acid and an undetermined phenol in very small amount, and apparently a trace of salicylic acid.

The sesquiterpene contained in this oil is a slightly viscid liquid, having a pale straw colour and a delicate rose-like fragrance. Although it was not possible to obtain from it any solid derivative, such as the hydrochloride, nitrosochloride, nitrosite, or nitrosate, and thereby definitely characterise it, it is evidently not identical with either of the previously known optically inactive sesquiterpenes, humulene and limene (*Trans.*, 1895, lxvii., 60, 780; and 1904, lxxxv., 416), and may therefore be regarded as a compound which has not hitherto been described. Its molecular refraction indicates that it belongs to the group of dicyclic sesquiterpenes with two ethylenic linkings.

*125. "*Mobility of Substituents in Derivatives of β-Naphthol.*" By JOHN THEODORE HEWITT and HERBERT VICTOR MITCHELL.

The authors found that when *p*-nitrobenzenediazonium chloride was added to an alkaline solution of 1-bromo-2-naphthol, coupling immediately occurred. The resulting substance when purified was free from halogen, and on analysis proved to be identical with *p*-nitrobenzeneazo-β-naphthol; the bromine atom had consequently been dis-

placed by the benzene group. The generality of the reaction was shown by examining the behaviour of the corresponding chloro- and iodo-β-naphthols, whilst alkaline bromonaphthol was also treated with diazotised solutions of the following amino-compounds:—*o*-, *m*-, and *p*-Toluidines, *o*- and *m*-nitroanilines, 2:4-dinitroaniline, *p*-phenetidine, *o*- and *p*-aminobenzoic acids, β-naphthylamine, and the 6- and 8-monosulphonic derivatives of the latter base.

Incidentally, the acetyl-derivative of 1-bromo-β-naphthol was prepared; this proved to be a well-crystallising solid, m. p. 56°, and not an oil, as described by Canzoneri (*Gazetta*, 1882, xii., 431).

The nitroso-group in nitroso-β-naphthol is also mobile, treatment with nitric acid furnishing 1:6-dinitro-2-naphthol.

Discussion.

Mr. W. A. Davis referred to his results, summarised in the Reports for 1900 to 1903 of the Committee of the British Association on Isomeric Naphthalene Derivatives, showing the mobility of a halogen atom in position 1 in β-naphthol under the influence of hydriodic acid or nitric acid. Halogen atoms in other positions in the nucleus were not affected, and the same was true of an α-halogen in a non-hydroxylated naphthalene nucleus. The sensitiveness of the α-halogen atom in the naphthol was to be attributed to the formation of an additive compound at the αβ-ethenoid linking, as was well illustrated in the case of nitric acid by the production of the nitro-bromo-keto-compounds.

Dr. Hewitt, in replying to the President, remarked that he had not encountered any statement concerning the displacement of halogen atoms by azo-groups. The product of the action of diazotised aniline on an alkaline solution of bromo-δ-naphthol, though very tarry, evidently contained some benzeneazo-β-naphthol, since if nitrated in concentrated sulphuric acid solution a certain amount of *p*-nitrobenzeneazo-β-naphthol could be isolated.

Mr. Davis's experiments on the action of hydriodic acid on α-halogen-substituted β-naphthols seemed to be of a different nature, in that the compounds were reduced; it was not the direct replacement of negative atoms by other complex groups.

*126. "*The Decomposition of Nitrocellulose.*" By Oswald Silberrad and Robert Crosbie Farmer.

Great uncertainty has hitherto prevailed as to the products which result from the gradual deterioration of nitrocellulose. An exhaustive examination of the decomposition products obtained on storage of 100 kilogrms. of gelatinised nitrocellulose for twenty-three weeks at 54—55° in a damp atmosphere led to the identification of the following products:—Ethyl nitrate, ethyl nitrite, ethyl alcohol, nitric and nitrous acids, ammonia, formic, acetic, butyric, dihydroxybutyric, oxalic, tartaric, *iso*saccharinic, and hydroxypyruvic acids. Carbohydrates were also present.

*127. "*Note on Gunpowder and Bullets, made about* 1641, *Recently Discovered in Durham Castle.*" By Oswald Silberrad and William Slessor Simpson.

For the materials for this investigation we are indebted to the Secretaries of this Society for putting us into communication with J. T. Johnson, Esq., of Durham School, who kindly forwarded samples of the bullets and gunpowder in question. The ammunition was found in a bucket which had been walled up in the roof of Durham Castle, probably having been placed there about 1641, when the Castle was armed against a Scottish raid.

The bullets consisted of roughly moulded spheres of lead of two different sizes, some being 1·5 c.m. and others 1·8 c.m. in diameter. On analysis they were found to consist of 99·17 per cent of lead, and to contain a small quantity of iron and silver together with traces of bismuth, arsenic, and antimony.

The gunpowder, on analysis, was found to approximate closely in composition to the black powder now used in this country. In appearance, however, it differed widely from powder manufactured at the present day, the ingredients having been merely ground and mixed together, no attempt at granulation having been made.

| | Analysis of powder from Durham Castle. On sample. | On dry material. | Proportions used at present time in this country. |
|---|---|---|---|
| Potassium nitrate | 73·99 | 74·81 | 75 |
| Carbon .. .. .. | 14·71 | 14·87 | 15 |
| Sulphur .. .. | 9·98 | 10·09 | 10 |
| Moisture .. .. | 1·10 | | |
| | 99·78 | | |

These results are somewhat surprising, since the compositions used in this country during the seventeenth century all contained a much higher percentage of sulphur. It seems indeed probable that this powder was of Prussian origin, Prussian musket powder being the only explosive of this composition in use at that date.

The calorimetric value was determined by firing a charge at a density of loading 0·48 in a closed vessel suspended in a calorimeter.

The pressure recorded was 9·7 tons per sq. in., or 1478 atmospheres. The calorimetric value = 694 calories per grm.

This is in close agreement with the figure given by ordinary black powder.

The critical time of burning was determined at a density of loading of 0·230. The apparatus used was similar to that described by Sir Andrew Noble (*Phil. Trans.*, 1905, ccv., 201). The pressure was, however, taken on a crusher copper, and the time measured by means of a calibrated tuning-fork, which was simultaneously made to plot a record on a revolving drum.

The pressure recorded at this density was 4·51 tons per sq. inch, 687 atmospheres; ordinary black powder fired at this density gives a pressure of 686 atmospheres (Sir Andrew Noble, *Phil. Trans.*, 1905, ccv., 15). The critical time of burning observed was 0·0030 second. This is more rapid than that of the granulated powders now in use.

Unfortunately, we were debarred from carrying out further experiments at higher densities owing to the small amount of material at our disposal.

128. "*The Constitutian of Acetone.*" By Millicent Taylor.

The action of sodium and of magnesium methyl iodide on acetone has been studied. So-called "sodium acetone," the product of the action of sodium on highly dilute acetone, is shown to consist of a mixture of caustic soda with a small proportion of sodium *iso*propyloxide; this is deduced from the percentage of sodium in the substance, and also from its behaviour with acid chlorides.

The only esters obtained by the action of chloroformic ester and *p*-nitrobenzoyl chloride on "sodium acetone" are ethyl *iso*propyl carbonate and *iso*propyl-*p*-nitrobenzoate respectively.

In no case was any indication of the formation of *iso*propenyl esters obtained. Moreover, in one case in which the yield of each product was determined, it was found that the total acid chloride employed was converted into acid anhydride, acid (or sodium salt), and *iso*propyl ester, leaving no possibility of the formation of other esters.

By the action of acetone on magnesium methyl iodide at the ordinary temperature and up to 140° no methane was liberated.

These results prove that acetone does not behave, either towards sodium or Grignard's reagent, as *iso*propenyl alcohol, $CH_3{\cdot}C(OH){:}CH_2$, and also that it does not contain any hydrogen directly replaceable by sodium under the conditions investigated.

129. "*Diazo-derivatives of the Mixed Aliphatic Aromatic ω-Benzenesulphonylaminobenzylamines.*" By Gilbert Thomas Morgan and Frances Mary Gore Micklethwait.

A study of the action of nitrous acid on the benzenesulphonylaminobenzylamines,—

$$NH_2{\cdot}C_6H_4{\cdot}CH_2{\cdot}NH{\cdot}SO_2{\cdot}C_6H_5,$$

showed that diazoimides could be obtained from the ortho- and meta-compounds, but not from the para-isomeride.

*o*-Nitrobenzylamine was converted successively into *benzenesulphonyl-o-nitrobenzylamine*,—

$$NO_2{\cdot}C_6H_4{\cdot}CH_2{\cdot}NH{\cdot}SO_2{\cdot}C_6H_5,$$

and *ω-benzenesulphonyl-o-aminobenzylamine*,—

$$NH_2{\cdot}C_6H_4{\cdot}CH_2{\cdot}NH{\cdot}SO_2{\cdot}C_6H_5.$$

This acylated diamine, when diazotised in strong hydrochloric acid, yielded a soluble diazonium salt; this substance, on treatment with aqueous sodium acetate, furnished a colourless mixed *diazoimide*,—

$$C_6H_4{<}^{CH_2}_{N_2\text{--}}{>}N{\cdot}SO_2{\cdot}C_6H_5,$$

which, like the yellow aromatic para-diazoimides, is reconverted into the diazonium salt by the action of cold concentrated hydrochloric acid.

*ω-Benzenesulphonyl*-m-*aminobenzylamine* also gave rise to a soluble diazonium salt which, although not affected by aqueous sodium acetate, underwent condensation in the presence of excess of potassium bicarbonate, and furnished a pale yellow *diazoimide* isomeric with the preceding compound.

These diazoimides owe their formation to the presence of hydrogen in the acylamino-group, $\cdot NH{\cdot}SO_2{\cdot}C_6H_5$, for when this atom is replaced by methyl, condensation does not occur. The three benzenesulphonylaminobenzylamines and the methyl derivatives of the ortho- and meta-bases all yielded azo-β-naphthol derivatives.

130. "*Influence of Substitution on the Formation of Diazoamines and Aminoazo-compounds.* Part V. s-*Dimethyl*-4 : 6-*diamino*-m-*xylene*." By GILBERT THOMAS MORGAN and ARTHUR CLAYTON.

s-*Dimethyl*-4 : 6-*diamino*-m-*xylene* (m. p. 100—101°), which was obtained by the following series of operations:—

$$C_6H_2Me_2(NH_2)_2 \rightarrow C_6H_2Me_2(NH{\cdot}SO_2{\cdot}C_6H_5)_2 \rightarrow$$
$$\rightarrow C_6H_2Me_2(NMe{\cdot}SO_2{\cdot}C_6H_5)_2 \rightarrow C_6H_2Me_2(NHMe)_2,$$

yielded a colourless *dinitrosoamine*, $C_6H_2Me_2(NMe{\cdot}NO)_2$, and on treatment with *p*-nitrobenzenediazonium chloride gave rise to a small amount of the *aminoazo*-compound, $NO_2{\cdot}C_6H_4{\cdot}N_2{\cdot}C_6HMe_2(NHMe)_2$, which separated from benzene either in brownish grey crusts or in dark red prisms or diamond-shaped plates melting at 218°. This result shows that the symmetrical dimethylation of 4 : 6-diamino-*m*-xylene does not inhibit the production of an orthoazo-derivative.

(To bd continued).

## SOCIETY OF CHEMICAL INDUSTRY.

(LONDON SECTION).

*Ordinary Meeting, June 11th, 1906.*

Mr. A. G. SALAMON in the Chair.

"*On Purifying and Stabilising Gun-cotton.*" By ROBERT ROBERTSON, M.A., D.Sc.

This communication—published by permission of the War Office—deals with large scale experiments having for their object the best means of obtaining a pure and stable gun-cotton by a boiling process.

The investigations are described in two main divisions; first, those in which the effects of variations in the relative duration of the different boilings are examined, and, secondly, those in which alkaline treatments were employed.

For the elimination of impurities from the gun-cotton and the rapid attainment of a stable product, boiling in dilute acid at the beginning of the process is superior to an alkaline treatment which has the additional disadvantage of tending towards an undue hydrolysis of the ester itself. It is brought out that the acid hydrolysis must not be unduly curtailed or elimination of the impurities will be rendered difficult.

The importance of retaining a certain degree of acidity in the first boiling is also shown, as is also the disadvantageous procedure of prolonged later boilings.

As a consequence of the foregoing the method of boiling was adopted, viz., a series of boilings characterised by long initial (acid) boilings followed by shorter (practical neutral) boilings.

"*The Determination of Indigotin in Commercial Indigo and in Indigo-yielding Plants.*" By CYRIL BERGTHEIL and RICHARD VICTOR BRIGGS.

The authors have investigated the standard methods of estimating indigotin in commercial indigo. It is shown that all the methods dealt with are reliable when applied to pure indigotin, but that in application to commercial indigo the impurities present lead to errors; only those methods depending on the oxidation or reduction of solutions of sulphonated indigo are found to be applicable in this case. The methods which have been proposed for removing the undissolved impurities from solutions of sulphonated indigos are discussed, and it is shown that both that of Rawson (*Journ. Soc. Chem. Ind.*, 1899, xviii., 251) and that of Grossmann (*Journ. Soc. Chem. Ind.*, 1905, xxiv., 308) lead to precipitations of indigotin, and consequent errors in the results obtained. An alternative method of purifying the solution with freshly precipitated barium sulphate is described and shown to be free from the errors in the previous methods proposed.

The effect of the impurities which remain in solution is traced by making up indigos of known degrees of purity from pure indigotin and substances derived from the waste water from indigo manufacture, and is found to an error of from 1 to 2 per cent, for an indigo of average quality, in the methods investigated. The effect of indirubin is similarly traced. Oxidation with permanganate is found to supply a readier method of determining indigotin than reduction, methods depending on the latter principle being more troublesome and only applicable in conjunction with Grossmann's method of purification, which involves an error; they are, however, the most useful in dealing with indigos containing much indirubin.

A method for the determination of indigotin in indigo-yielding plants by precipitation from an extract with persulphuric acid has been described by Rawson ("Report on the Cultivation and Manufacture of Indigo," 1904), but it has been shown by Bergtheil (*Trans. Chem. Soc.*, 1904, lxxxv., 870) that the results obtained by its application do not coincide with those derived by fermentation with indigo enzyme. The authors have investigated the cause of this anomaly, and found it due to the employment of an excess of persulphuric acid by Rawson, and that, by suitably modifying the method, results may be obtained which agree with those obtained by fermentation.

"*Recent Progress in the Cement Industry.*" By BERTRAM BLOUNT.

The author compares the condition of the cement industry in 1886 and at the present time, pointing out that at the former date somewhat crude methods of manufacture were in use, whereas now improved processes are in operation under scientific control. The world's production of Portland cement has increased from 2,500,000 tons to some 11,000,000 tons in the last 20 years, and the centre of the industry has shifted from Europe to the United States. The need for cheaper production to meet the competition of new centres of manufacture has stimulated the revision and improvement of the older methods of manufacture, and these have now been entirely remodelled; a great factor in the development which has occurred is the successful application of the rotatory process. A typical works of 1886 and a modern works with the latest form of plant are described and contrasted in respect to the mode of working and the cost and quality of the cement produced, mention

being made in the paper of the increased use of methods of mechanical conveyance and consequent diminution of labour.

The growing utilisation of cement for all structural purposes and for special methods of construction, such as the various systems of armoured concrete, is dealt with, and the present position of the industry considered, taking into account on the one hand the growing tendency of each locality to produce its own cement, and on the other, the much greater energy and technical skill of manufacturers. Cements other than Portland cement are discussed, and it is shown that, though the trade in them is large, and in some cases increasing, its importance relative to that of the Portland cement industry is diminishing. The utilisation of blast-furnace slag for making Portland cement, cement of the puzzuolana class, and Passow cement is referred to. Cement is made on the advantages of puzzuolana as an adddition to Portland cement, and the preparation of white Portland cement is described.

The second part of the paper deals with improvements in controlling the quality of cement in the works and by the user which have been made during the last 20 years. Suggestions are made for further improvements in specifications. The outcome of the investigations which have taken place during the period under discussion on the chemistry of cement is described, the conclusions which appear to be best founded concerning both the composition of cement clinker and the reactions involved in the setting of cement being set forth.

A forecast is given of the lines on which the manufacture of Portland cement is likely to be evolved, and the advantages of some method by which the raw materials can be fused so as to avoid the present necessity of intimate grinding and mixing are indicated. The opinion is expressed that on its technical side the industry at the present date exhibits great and satisfactory advance from its status in 1886.

## FARADAY SOCIETY.

*Ordinary Meeting, June 12th, 1906.*

Mr. W. Murray Morrison in the Chair.

A paper on "*The Electrolytic Deposition of Zinc, using Rotating Electrodes*," by Dr. T. Slater Price and Mr. G. H. B. Judge was communicated by Dr. F. Mollwo Perkin. (Will be inserted in full).

Dr. F. Mollwo Perkin described "*A Simple Form of Rotating Cathode for Electro-chemical Analysis.*" (See p. 283).

Mr. S. Binning and Dr. F. Mollwo Perkin read a paper on "*The Electrolysis of Solutions of Thiocyanates in Pyridine and in Acetone.*"

On oxidation of thiocyanates with chlorine, persulphates, &c., a yellow colouring matter—canarine—is obtained. By electrolysis of aqueous acidified solutions of thiocyanates an apparently similar product, which was originally described in 1884 by Lurdow, is obtained. The authors consider that this substance is not identical with the canarine obtained by chemical means, because it shows certain reactions not given by the oxidation product. They find that in alkaline solutions no colouring matter is produced, but that cyanides are apparently formed. A difficulty met with in the electrolysis was the formation of the colouring matter on the anode surface, which caused a great resistance to the passage of the current. The difficulty was got over by using a lead cathode on which bristles had been fixed. This was rapidly rotated within a cylindrical platinum anode, the bristles cleaning the anode surface as the cathode rotated. With a current of 5 ampères (10 ampères per square decimetre) the E.M.F. was 5 volts.

Anhydrous ammonium thiocyanate readily dissolves in dry acetone and pyridine, in either case there being no difficulty in obtaining a 20 per cent solution. These solutions readily conduct the electric current. In the case of the acetone solution with a current of 1·5 ampères (3 ampères per square decimetre) the E.M.F. required is 6·7 volts. With pyridine for the same current it is about 9 volts. In the case of the acetone solution a yellow amorphous powder separates out. With the pyridine solution the liquid becomes orange-red, but no precipitate is produced. On pouring this orange solution into a large excess of water an orange precipitate falls out. These two substances are certainly not identical with the canarine obtained by oxidation; at present the authors are unable to say whether the product obtained from acetone is the same as that produced from pyridine. It is found that when a lead anode is employed in the pyridine solution it goes into solution; lead thiocyanate is produced and metallic lead is deposited at the cathode.

## NOTICES OF BOOKS.

*The Elements of Chemical Engineering.* By J. Grossmann, M.A. Ph.D., F.I.C. London: Charles Griffin and Co., Ltd. 1906.

The scheme of this book, to which Sir William Ramsay contributes a preface, is as excellent as its working out, and every student of chemistry attending a technical course should obtain a copy. The object is to supply the link between the laboratory processes with which his training in pure chemistry should have made the student thoroughly familiar, and the corresponding manufacturing processes, which often present unexpected difficulties. For one thing, in the latter a new factor has to be taken into consideration, and has indeed become of paramount importance, and that is the cost of the process, including labour, which the student in the laboratory has been accustomed to neglect altogether. The author has endeavoured—and, we may add, with complete success—to make the transition between an operation on a small scale and its counterpart in the works, when tons have to be used instead of grammes, as gradual as possible. He takes the apparatus commonly employed in the laboratory, and by considering its limitations for manufacturing purposes, leads up to the construction and use of its equivalent in the works. Thus, for the beaker and evaporating dish, used for mixing, dissolving, evaporating, &c., the technical equivalents, the Thelen pan, iron or lead vessels, are substituted, and so on; constant appeals are made to the common sense of the student, who could hardly fail to be interested in the book, owing to the novel way in which the subject is presented and the author's particularly lucid style.

*Systematic Inorganic Chemistry.* By R. M. Caven, D.Sc. (London), and G. D. Lander, D.Sc. (St. Andrews and London). London, Glasgow, and Dublin: Blackie and Son, Ltd. 1906.

This book is designed specially for the use of older students, and consequently the more elementary parts of the subject are omitted to make room for the further consideration of such aspects as are not dwelt upon in less advanced text-books. The book thus gives an outline of the inorganic work of a degree student, and it will be found of considerable value, especially from a recapitulatory point of view. The authors possess the power of putting forward familiar facts in somewhat novel ways, which may be found of assistance to the memory, and the summaries of some theoretical subjects, such as the atomic and molecular theories, are both concise and complete. The elements are taken in groups according to the Periodic Law, and special attention is paid to the comparison of the properties and behaviour of the individual members of each group. The insertion of fuller references to original papers, to

which advanced students might be supposed to have access, would be an advantage from many points of view.

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*Joseph Priestley.* By T. E. THORPE, F.R.S. London: J. M. Dent and Co. New York: E. P. Dulton and Co. 1906.

THIS life of Joseph Priestley will appeal to a large circle of readers, for it throws much light upon the intellectual activity of the eighteenth century, and incidentally also upon the methods of suppression adopted by our forefathers to stamp out views not approved by them. The famous Birmingham riots are dealt with very graphically, the account of an eye-witness, Miss Martha Russell, being quoted for this purpose. The book gives a detailed account of Priestley's scientific work, the value of which is discussed in a very critical spirit, the final result being to place it perhaps somewhat lower than is usually done. Long quotations are also made from his book "Experiments and Observations on Different Kinds of Air," and Dr. Thorpe gives a very interesting appreciation of it and summary of its contents.

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*The Dynamics of Living Matter.* By JACQUES LOEB. New York: The Columbia University Press. London: Macmillan and Co., Ltd. 1906.

VOLUME VIII. of the excellent Biological Series issued by Columbia University is based upon the lectures delivered by the author before the University in the spring of 1902. It seems regrettable that the book could not have been published rather sooner after the course of lectures, but the subject has been brought down to a more recent date and treated considerably more fully, and many who remember the interest the lectures awakened in the first instance will be glad of an opportunity of reading them in this form. The chapters on the general chemistry of life phenomena, the physical constitution of living matter, and the effects of heat and radiant energy on living matter will be found by no means unduly difficult of comprehension by those whose biological knowledge is slight, and the general character of the book is exceediegly stimulating, for it contains full accounts of the author's own important investigations, and while his views are unmistakably discernible in every page, it is written in a temperate spirit.

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*Notes on Electrochemistry.* By F. G. WIECHMANN, Ph.D. New York: McGraw Publishing Company. 1906.

THIS small book is intended to give a general survey of electrochemistry to be used by students as an introduction to larger works, and also by chemists interested in the applications of electricity. Its use may possibly break the way for the beginner, but no student should attempt to cope with the problems and difficulties of electrochemistry until he has thoroughly mastered the elementary principles both of chemistry and mathematics. Hence, it should be superfluous in a book of this kind to give definitions of chemical equivalents for instance, or explanations of the meaning of $10^6$ and $10^{-6}$, and the fact that these and similar explanations are included leads us to regard the book as meant merely to provide a short cut to a knowledge of electrochemistry for the student who has not had the preliminary training which is absolutely indispensable for a thorough understanding of the subject. As for its contents, the book gives an introduction of definitions and explanations of the terms used, also an outline of the electrolytic theory, and a sketch of some of the applications of electrochemistry in technology. These are grouped as direct and indirect processes, the first including electro-deposition for solutions, while the second group comprises electro-depositions from fused electrolytes, and all electro-thermic processes. The difficulty of giving in a space of some forty pages an anything like adequate idea of most of the common applications no doubt accounts for the slightness of the treatment, which is such as to give in some cases a very imperfect and even erroneous view of the actual processes.

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*A Text-book of Assaying.* By C. and J. J. BERINGER. Revised by J. J. BERINGER. Tenth Edition. London: Charles Griffin and Co., Ltd. 1906.

THIS book has been universally recognised as one of the best of its kind and size, and it is so well known that it is hardly necessary to point out its special merits. For the preparation of the tenth edition the text has been thoroughly revised, and the chapter on the wet methods of assaying for lead has been entirely re-written.

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*Peace and War.* By CH. RICHET. Translated by MARIAN EDWARDES. London: J. M. Dent and Co. 1906.

THIS book, which is translated from the French, deals with the question whether, in view of the psychological nature of mankind, a state of unbroken peace is possible, and, furthermore, desirable. The author first discusses the desirability and then the possibility of the abolition of war, which a moment's reflection will show is hardly the most convincing method of considering the subject, and two-thirds of the book is devoted to arguments with which the majority of readers will agree, showing that war is an evil, although it may be pointed out that the deduction based upon "the survival of the unfit" is of more force against compulsory than voluntary military service. The last part of the book contains some sensible, though perhaps not original, remarks on education on pacific principles as a means of leading to the abolition of war and its attendant evils.

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*Les Industries de la Conservation des Aliments.* ("The Industries Connected with the Preservation of Foods"). By X. ROCQUES. Paris: Gauthier-Villars. 1906.

THERE seems to be no limit to the issue of books on the subject of preservatives in food, but the one now under review is a not unwelcome addition to their number; it takes a very moderate view of the vexed question, and, moreover, gives a complete account of the various physical methods employed to hinder putrefaction. As regards the addition of antiseptics, only a small part of the book is devoted to its consideration; the author believes that the opinion of the majority of experts is that such additions are harmful to health, and ought to be forbidden by law, and with this view he concurs, after discussing the nature and use of the most common preservatives. A special chapter deals with the preservation of eggs, which is of great importance in France, where the poultry-keepers are not, as a rule, successful in obtaining new laid eggs in winter. The greater part of the book is occupied with the description of the apparatus and methods used to preserve food-stuffs by the application of high or low temperatures, or by desiccation, of which subjects M. Rocques shows that he is well qualified to write authoritatively.

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*The Dipping Refractometer.* Third Edition. Jena: Carl Zeiss. 1905.

THE method of examining fats and oils with the refractometer is being continually more used by analytical chemists, possessing as it does the advantages of being quick, accurate, and simple. With the Dipping Refractometer, the use of which is clearly and fully described in this pamphlet, it is claimed that a careful worker can get results accurate to $\pm 3{\cdot}7$ units in the fifth decimal place of $n_D$. The method of measuring the refraction of light in a liquid by immersing the prism, after a little practice with this instrument, is as simple as taking its temperature with a thermometer, and the border-line appears much sharper than in other refractometers, so that the degree of accuracy is considerably greater. In combination with the heating spiral and water pressure regulator, the Dipping Refracto.

meter can be used to determine the refractive index of beer, albumen in blood, cane-sugar, and all kinds of salts in solution, and considering the wide applicability of the method, the price of the instrument and its accessories is by no means high.

## CORRESPONDENCE.

### PROPOSED SOCIETY OF ALCOHOL RESEARCH.

*To the Editor of the Chemical News.*

Sir,—I take the liberty of calling your attention to a letter which appears in the Correspondence columns of the current issue of *The Autocar* under the above title, in the hope that you may see your way to further the proposal in your columns, seeing that the subject is vital to the motor and agricultural industries, and that we look to chemists to solve the difficulty.—I am, &c.,

Radford Cooke.

19, Hanover Square, London, W.,
June 30, 1906.

## CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxlii., No. 23, June 5, 1906.

**Researches on Rubidium, Cæsium, and Lithium.**—M. de Forcrand.—The author finds the heat of solution of hydrated rubidium hydrate, $RbOH + H_2O$, to be 3·702 cals. at +15°. He deduces this number from a number of concordant experiments made at about +20°. The heat of solution of pure rubidium hydrate, RbOH, calculated in the same manner, is 14·264 cals. at 15°. Cæsium has a hydrate, $CsOH + H_2O$, which is obtained commercially. The heat of solution at 15° is 16·423 cals., whilst that of the hydrate, $CsOH + H_2O$, is 4·317 cals. at 15°, from which may be deduced $CsOH$ sol. + $H_2O$ liq. = $CsOH + H_2O$ sol. . . +12·106 cals. The slow evaporation of very concentrated solutions of cæsium in the cold leaves fine needles of a secondary hydrate, probably of formula $CsOH + 3$ or $4\ H_2O$, which melts about 25°. Lithium hydrate, $LiOH + H_2O$, when dissolved absorbs 0·720 cal. at 18°, whilst LiOH absorbs +4·477 cals., from which may be deduced LiOH sol. + $H_2O$ liq. = LiOH + $H_2O$ sol. +3·757 cals.

**Action of Silicon Chloride on Nickel.**—Em. Vigouroux.—During an investigation of the action of silicon chloride on nickel, the author observes two limits of siliciuration. The lower limit corresponding to $Ni_4Si$, a substance hitherto unknown, but now perfectly defined, its action on a magnet proving it to contain no free nickel. The higher limit, giving the body $Ni_2Si$, a substance well known. It is not impossible that higher temperatures may be capable of inducing the formation of more strongly siliciuretted compounds.

**Decomposition of Copper Sulphate by Methylic Alcohol.**—V. Auger.—The author finds that sulphate of copper is decomposed by methylic alcohol, both in the cold and when hot, and whether anhydrous or hydrated, and his explanation of the phenomenon is that the methylsulphuric ether-acid is formed. The sulphate of copper in solution being always slightly dissociated, the formation of this acid-ether disturbs the equilibrium $SO_3 \rightleftarrows$ basic salt + sulphate, and causes the formation of a new proportion of the latter. Ethylic alcohol also gives a basic salt, but in extremely small proportion. It is thus seen that methylic alcohol, the first term of the fatty alcohols, always shows a much greater activity than the superior homologues.

**Dibromo-dimethyl- and Diethylamidobenzoylbenzoic Acids and their Derivatives.**—E. Séverin.—When phthalic anhydride is condensed with the dialcoylanilines in presence of $AlCl_3$, dialcoylamidobenzoylbenzoic acids are obtained. The author's researches were carried out upon dibromophthalic acid, which he considers as para-derivatives 1 . 2 . 3 . 6. The anhydride of this acid is used to prepare the following bodies:—Dibromodimethylamidobenzoylbenzoic acid,—

$$C_6H_2Br_2 < \begin{matrix} COC_6H_4N < \begin{matrix} CH_3 \\ CH_3 \end{matrix} \\ COOH \end{matrix} ;$$

dibromoacetylamidobenzoylbenzoic anhydride,—

$$C_6H_2Br_2 < \begin{matrix} COC_6H_4N < \begin{matrix} CH_3 \\ CH_3 \end{matrix} \\ CO \\ CH_3CO > O \end{matrix} ;$$

also the ethylic ether, methylic ether, nitroso-derivative, and a few other compounds.

## MISCELLANEOUS.

**Royal Institution.**—A General Monthly Meeting of the Members of the Royal Institution was held on the 2nd inst., His Grace the Duke of Northumberland, K.G., F.R.S., President, in the Chair. The Hon. Arthur Stanley, M.V.O., M.P., Dr. T. P. Hyslop, and Dr. J. G. McKendrick were elected Members. The special thanks of the members were returned to the Rt. Hon. Lord Sanderson, G.C.B., K.C.M.G., for his donation of five guineas to the fund for the Promotion of Experimental Research at Low Temperatures.

**Compounds of Mercuric Iodide and Free Monomethylamine.**—Maurice François.—If $HgI_2,CH_5N$ is the possible compound of mercuric iodide and methylamine containing the least quantity of methylamine, and if $k$ is the tension of dissociation, it is evident that the mercuric iodide ought only to absorb the methylamine in proportion as the tension is greater than the dissociation tension $k$. This would lead to the compound $HgI_2(CH_5N)_2$, the one immediately below, without allowing a more complete decomposition. This is theoretically true in the absence of air, and is practically realised even in presence of air. The compound $HgI_2.CH_5N$ is yellowish white; it only yields red mercuric iodide with difficulty and after long exposure to air. It can be prepared when a solution of free methylamine is poured into an excess of potassium iodide solution saturated with mercuric iodide; it is then crystalline.—*Comptes Rendus*, cxlii., No. 22.

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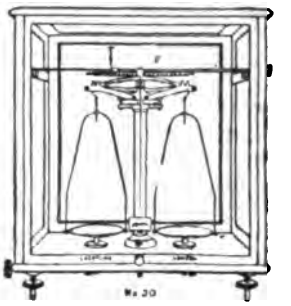

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VOL. XCIV., No. 2433.

ON THE

# CONDENSATION PRODUCTS OF α-NAPHTHOL AND BENZOPHENONE CHLORIDE.

By ALBERT G. SHRIMPTON, B.Sc.

THE series of condensation products of benzophenone chloride and benzal chloride with the alcohols, phenols, &c., was commenced by Wicke (*Annalen*, 1857, cii., 356). He examined the action of sodium methoxide and its homologues on benzal chloride, *e.g.*,—

$$C_6H_5.CHCl_2 + 2CH_3ONa = C_6H_5.CH(OCH_3)_2 + 2NaCl,$$

in which the compound dimethoxy-benzylidene was formed. Dr. J. E. Mackenzie continued the work (*Trans. Chem. Soc.*, 1896, lxix., 985), using benzophenone chloride instead of benzal chloride, *e.g.*,—

$$(C_6H_5)_2CCl_2 + 2CH_3ONa = (C_6H_5)_2C.(OCH_3)_2 + 2NaCl.$$

By this process he prepared dimethoxy-diphenylmethane, also—

Diethoxy-diphenylmethane .. $(C_6H_5)_2:C:(O.C_2H_5)_2$
Dibenzoxy-diphenylmethane . $(C_6H_5)_2.C.(OCH_2.C_6H_5)_2$

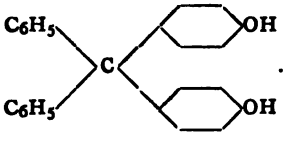
Later (*Ibid.*, 1901, lxxix., 1204), he prepared :—

Dipropyloxy - diphenyl - methane .. .. .. $(C_6H_5)_2C(O.CH_2CH_2.CH_3)_2$
Di-isobutyloxy-diphenyl-methane .. .. .. $(C_6H_5)_2C[OCH_2.CH.(CH_3)_2]_2$

He also prepared 4 : 4′-dihydroxy-tetraphenylmethane,—

$$(C_6H_5)_2C(C_6H_4OH)_2,$$

by using sodium phenoxide. It will be noticed that in the formation of the previous products the reaction was directed to a great extent by the presence of sodium in the hydroxyl group. But in the case of the last mentioned substance preference is shown for the benzene nucleus :—



No phenoxy compound could be isolated. (Another peculiarity is shown by this substance crystallising with two molecules of ether). It can also be prepared by the direct action of benzophenone chloride on phenol.

Hence it was desirous to continue the study by examining the action of benzophenone chloride on α-naphthol.

For this work *benzophenone chloride* was prepared according to the method of Kekulé and Franchimont. Thirty grms. of benzophenone and 35 grms. of phosphorus pentachloride (in molecular proportions) were placed in a round-bottom flask connected to a reflux air condenser, which terminated in a calcium chloride guard-tube. On careful heating in an oil-bath, the benzophenone began to boil at 140—150° C., when the phosphorus pentachloride melted. The temperature was gradually raised to 207°, when the reaction proceeded fairly vigorously, and was maintained at this temperature for four hours and a-half. The resulting products were brownish.

$$(C_6H_5)_2CO + PCl_5 = (C_6H_5)_2CCl_2 + POCl_3.$$

The products were separated by distillation under reduced pressure. 20·55 grms. of phosphorus oxychloride distilled over at 45·5—46° C. under 53 m.m. pressure. The residue was heated to 100° for a few minutes to ensure the complete separation of the oxychloride. Benzophenone chloride began to distil over at 198° C.

| | | | |
|---|---|---|---|
| 198° C. | under pressure of 38 m.m. | .. | 16·2 grms. |
| 200—204° C. | „ „ 43 „ | .. | 17·5 „ |
| + 204° C. | „ „ 43 „ | .. | 3·46 „ |

In all 36·81 grms. of benzophenone chloride were collected, being 94·4 per cent of the theoretical.

In distilling this substance under reduced pressure great trouble was experienced by the liquid bumping over. This was remedied by bending the exit tube of the Wurtz flask, first upwards at about 30° to the neck, and again downwards. Also benzophenone chloride readily attacks rubber, so it is necessary to push the exit tube of the flask as far as possible through the rubber cork of the condenser.

*Dihydroxy-diphenyl-di(α)-naphthyl-methane.*

*Diphenyl-di(α)-naphthol-methane*, $\begin{matrix}C_6H_5\\C_6H_5\end{matrix}\!\!>\!C\!<\!\!\begin{matrix}C_{10}H_6OH\\C_{10}H_6OH\end{matrix}$.

—This substance was formed by the condensation of α-naphthol with benzophenone chloride according to the equation :—

$$(C_6H_5)_2CCl_2 + 2C_{10}H_7OH = (C_6H_5)_2C(C_{10}H_6OH)_2 + 2HCl.$$

It is possible for the reaction to take place in three ways, excluding all the subsidiary actions :—The condensation taking place between the chlorine and the hydrogen of the hydroxyl group, giving rise to—

$$\begin{matrix}C_6H_5\\C_6H_5\end{matrix}\!\!>\!C\!<\!\!\begin{matrix}OC_{10}H_7\\OC_{10}H_7\end{matrix},$$

with the hydrogen atom of the naphthyl nucleus,—

$$\begin{matrix}C_6H_5\\C_6H_5\end{matrix}\!\!>\!C\!<\!\!\begin{matrix}C_{10}H_6OH\\C_{10}H_6OH\end{matrix},$$

or, lastly, a further action could take place by one molecule of water splitting off from the two hydroxyl groups (especially if the two hydroxyl groups were stereo-isomerically near to one another) forming—

$$\begin{matrix}C_6H_5\\C_6H_5\end{matrix}\!\!>\!C\!<\!\!\begin{matrix}C_{10}H_6\\C_{10}H_6\end{matrix}\!\!>\!O.$$

29·7 grms. of benzophenone chloride were mixed with 38·1 grms. of α-naphthol in a round bottomed flask fitted with a reflux air condenser terminating in a calcium chloride guard tube. The flask was heated on an oil-bath. At 68° the mass began to swell considerably, to char, and give off copious fumes of hydrochloric acid. The temperature was gradually raised to 200° for fifteen hours until the hydrochloric acid ceased to come off. During the operation a beautiful violet coloration was often observed, at first on the mixing of the substances and afterwards near the neck of the flask. The α-naphthol frequently distilled up into the condenser, often having the appearance of drops of water. The flask was disconnected and weighed. The loss in weight amounted to 9·0 grms. The theoretical loss due to the evolution of two molecules of hydrochloric acid is 9·12 grms. The residue was a very dark brown solid tar. At first a separation under reduced pressure was tried, but only the α-naphthol unacted upon distilled over. Weight of crude substance was 49·12 grms., which is equal to 87 per cent of the theoretical yield.

To extract this substance from the tar many methods had to be adopted. None were very successful, but the following gave the best results :—

1. The tar was removed from the flask with boiling benzol. On cooling, this yielded a fair crop of pinkish, sandy, microscopic crystals, but beyond this the use of benzoyl is not efficacious as it only deposits a very sticky unyielding tar.

2. A dilute solution of the substance in benzol, or better in chloroform, can be precipitated by shaking up with petroleum ether in the cold and quickly filtering off. The solution must be dilute, and excess of petroleum ether added, otherwise the tar separates out again.

3. The tar can also be shaken up or stirred with a solution of sodium hydrate. A fine madder-brown solution

having a blue fluorescence is obtained. This is filtered off from the rest of the tar (or decanted off). On the addition of hydrochloric acid the substance is precipitated as a pinkish white powder, which rapidly turns brown on standing.

4. Probably the best method is to place a little concentrated solution of the substance in a conical flask. To this is added an excess of alcohol, well shaken, and filtered directly.

(In another experiment a first extraction was made with boiling ether. When cold petroleum ether was added, a slight precipitate was obtained, which when dry had a a beautiful violet colour. But it showed no definite melting-point, apparently decomposing from 90° upwards). The precipitates were re-crystallised several times from chloroform, but up to now no satisfactory yield has been obtained.

Analysis gave the following figures:—

0·1053 grm. substance gave 0·3424 $CO_2$, 0·0548 $H_2O$. C = 88·57 per cent, H = 5·77 per cent. (Preliminary).

0·1408 grm. substance gave 0·4504 $CO_2$, 0·0650 $H_2O$. C = 87·24 per cent, H = 5·13 per cent.

$C_{33}H_{24}O_2$ requires C = 87·61, H = 5·31.
$C_{33}H_{22}O$ requires C = 91·24, H = 5·07.

This shows the substance to be dihydroxy-diphenyl-di-α-naphthyl methane. This is confirmed by a Raoult's cryoscopic determination by the depression of the freezing-point (using a Bechmann's apparatus), which gave for its molecular weight 465.

$C_{33}H_{24}O_2$ requires 452. $C_{33}H_{22}O$ requires 434.

This is further confirmed by the acetyl derivative, and also by the formation of the madder-brown compound with sodium hydrate.

Diphenyl di-α-naphthol methane is a white substance consisting of microscopic crystals, melting-point = 208·2—209·2° C. (with 210° exposed). It begins to darken at 204°, changing to grey, reddish brown, and finally melting to a brownish viscid liquid. When impure it soon becomes pinkish on exposure to air, and finally becomes a deep brown. This is probably due to oxidation. It is soluble in benzene, carbon disulphide, ether, acetone, and chloroform, less soluble in alcohol and petroleum ether. It dissolves in an aqueous solution of sodium hydrate, giving a madder-brown solution which shows a blue fluorescence. On the addition of mineral acids the substance is thrown down.

### *Attempt to prepare a Diacetyl Derivative of Diphenyl-Di-α-naphthol Methane.*

1·1 grm. of diphenyl-di-α-naphthol methane were mixed with 1·3 grms. of freshly fused sodium acetate and 4·8 grms. of acetic anhydride. The mixture was heated on a water-bath under a reflux condenser for four hours. By this time the product had become pasty. On cooling, it showed a brownish white crystalline structure. Water was added to the cooled mass and made just alkaline with sodium hydrate. The solid residue was filtered off, and thoroughly washed with water until there was no further smell of acetic acid. The substance was re-crystallised several times from acetone. The crystals consisted of small silky white needles and plates, which showed a definite melting-point of 202° C. They melted to a colourless liquid which showed no signs of colouring until the temperature of 208° was reached.

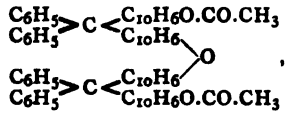
The quantitative results were disappointing, and unfortunately there was not enough substance to repeat them.

0·1453 grm. of substance gave $CO_2$ = 0·4617 and $H_2O$ = 0·0707 grm. C = 86·66 per cent, H = 5·41 per cent.

A diacetyl derivative requires C = 82·84 per cent, H = 5·22 per cent.

A monacetyl derivative requires C = 85·02 per cent, H = 5·26 per cent.

But a condensation between two monacetyl derivatives, such as—



requires C = 86·56 per cent, H = 5·15 per cent.

But a Raoult's cryoscopic determination by the depression of the freezing-point only gave 244·15 for the molecular weight.

### *A Second Condensation Product of Benzophenone Chloride with α-Naphthol.*

As the method adopted for the preparation of diphenyl-di-(α)-naphthol methane had resulted in such a large quantity of a troublesome tar, it was thought expedient to try a method in which the action could be more under control. For this purpose 21·7 grms. of benzophenone chloride were placed in a capacious flask, and 500 c.c. of petroleum ether, previously dried over metallic sodium, added. The flask was attached to a reflux Liebig's condenser terminating in a calcium chloride guard tube. About 0·5 grm. of α-naphthol were added. This at first turned the liquid a beautiful blue. On heating the flask on a water-bath the action commenced at 70° C., when hydrochloric fumes were evolved. The action slackened off after fifteen minutes. This operation was repeated by adding about 0·5 grm. of α-naphthol at a time until the whole of 26·5 grms. (theoretically required) had been added. The solution became yellow and deposited a little tar. But I believe this can be prevented by having pure ingredients and preventing the action from becoming too rapid. After a time the action commenced at 62° and became vigorous at 66—68°. It took thirty-six hours for the action to be completed.

The supernatant liquid was filtered off hot. On the addition of a few drops of sulphuric ether the liquid was clarified, and immediately began to deposit yellow crystals as a flocculent mass. The presence of tar prevents crystallisation. The residue in the flask was repeatedly washed with small quantities of boiling sulphuric ether, which dissolved out the tar, leaving a fairly pure product of a yellow colour behind. This was re-crystallised from acetone. The yield was far greater than that of the previous method.

This substance is soluble in benzol, ethyl alcohol, and acetone, less soluble in petroleum ether and sulphuric ether, fairly soluble in carbon disulphide and carbon tetra chloride. It consists of fine yellow microscopic crystals. They are stout prisms having an angle of 74—78°, and are isotropic.

The melting-point was sharp. Melting-point, 180·5—181° C. Up to now no satisfactory numbers have been obtained for this compound. The endeavour to obtain an acetyl derivative gave a negative result. This substance also shows good dyeing properties.

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**Action of Sulphuric Acid on Platinum.**—L. Quennessen.—The author makes a number of researches on the action of pure platinum on sulphuric acid of different degrees of concentration and also *in vacuo*, the intervention of oxygen having been clearly proved by former experiments. He shows that when commercial acid is used, it is clearly the oxygen of the air which intervenes as an oxidising agent, whilst with sulphuric acid in the absence of free oxygen it is the sulphuric anhydride in solution in the sulphuric acid which gives the necessary oxygen for oxidation owing to a phenomenon of the same kind as that which causes the preparation of sulphurous anhydride with some of the common metals. The mechanism can be understood if Dittmar's work on the dissociation of $SO_4H_2$ into $SO_3$ and water in very concentrated sulphuric acid be referred to.—*Comptes Rendus*, cxlii., No. 24.

## NOTES OF A COURSE OF LECTURES ON THE OLD AND NEW CHEMISTRY.*

### I. Extracts from different Authors relating to the Old Chemistry.

By Prof. Sir JAMES DEWAR, F.R.S., &c.

(Continued from p. 5).

*Works of Alchemical Adepts.—Sir Humphry Davy*, vol. viii.

"With respect to the views of the adepts of the alchemists who pretended to be in possession of the philosopher's stone, there cannot be two opinions.

"Nothing can be stronger or more just than what Lemery said of these men, 'That they professed an art without principle, the beginning of which was deceit, the progress of which was falsehood, and the end beggary.' There were, however, enlightened alchemists—men who modestly asserted that their means were inadequate to produce effects which they conceived to take place in the external world, who, considering the metals as generated beneath the surface of the earth by unknown operations, directed their views towards the discovery of these processes, and had for their highest object the construction of a laboratory in art correspondent to the great laboratory in nature.

"In this point of view, Helmont was an alchemist, Beccher was an alchemist, Stahl was an alchemist.

"These men, the fathers of philosophical chemistry, had witnessed the most extraordinary effects of the apparent conversion of metals into each other, even in artificial processes.

"It required considerable labour to prove that in the precipitation of copper by iron it was not an actual transmutation, which certainly is the obvious explanation. There is no physical impossibility in the idea. It appeared even more probable than some facts which have been since discovered.

"Even in these times of a more exalted science, after a series of connected discoveries, we have no right to say that what Stahl suspected—the generation of gold in nature—does not take place. We, it is true, have never seen it composed or decomposed; but our works are in moments, those of nature in ages; and but very lately there were many other bodies in the same case, which are now known not to be elementary."

*The Object of Alchemy and Attainments of the Alchemists. —Draper.*

"As there are veins of water in the earth and apertures through which the air can gain access, an analogy was inferred between its structure and that of an animal, leading to an inference of a similarity of functions. From this came the theory of the developments of metals in its womb under the influence of the planets. Already, however, in the doctrine of the transmutation of metals, it was perceived that to Nature the lapse of time is nothing —to man it is everything. To Nature when she is transmuting a worthless into a better metal, what signifies a thousand years? The aim of the cultivator of the sacred art should be to shorten the natural term; and since we observe the influence of heat in hastening the ripening of fruits, may we not reasonably expect that duly regulated degrees of fire will answer the purpose? by an exposure of base materials in the furnace for a proper season may we not anticipate the wished-for event? The Emperor Caligula, who had formerly tried to make gold from orpiment by the force of fire, was only one of a thousand adepts. Some trusted to the addition of a material substance in aiding the fire to purge away the dross of the base body submitted to it. From this arose the doctrine of the powder of projection and the philosopher's stone.

"This doctrine of the possibility of transmuting things into forms essentially different steadily made its way, leading in the material direction to alchemy, the art of making gold and silver out of baser metals, and in theology, to transubstantiation: transmutation and transubstantiation were twin sisters destined for a world-wide celebrity. . . . .

"While thus the Arabs joined in the pursuit of alchemy, their medical tendencies led them simultaneously to cultivate another ancient delusion, the discovery of a universal panacea or elixir which should cure all diseases and prolong life for ever. The mystical experimenters for centuries had been ransacking all nature from the yellow flowers which are sacred to the sun, and gold, his emblem and representative on earth, down to the vilest excrements of the human body. As to gold, there had gathered round that metal many fictitious excellences in addition to its real values; it was believed that in some preparation of it would be found the elixir vitæ. This was the explanation of the unwearied attempts at making potable gold, for it was universally thought that if that metal could be obtained in a dissolved state, it would constitute the long-sought panacea. Nor did it seem impossible so to increase the power of water as to impart to it new virtues, and thereby enable it to accomplish the desired solution. Were there not natural waters of very different properties? Were there not some that could fortify the memory, others destroy it; some reinforce the spirits, some impart dulness; and some, which were highly prized, that could secure a return of love? . . . Zosimus the Panopolitan had described in former times the operation of distillation, by which water might be purified; the Arabs called the apparatus for conducting that experiment an alembic. . . .

"The practical Arabs had not long been engaged in these fascinating but wild pursuits, when results of very great importance began to appear. In a scientific point of view, the discovery of the strong acids laid the true foundation of chemistry; in a political point of view the invention of gunpowder revolutionised the world.

"There were several explosive mixtures, automatic fire, liquid Greek fire, the knowledge of which was kept at Constantinople as a state secret. Of gunpowder, Marcus Græcus, whose date is probably to be referred to the close of the eighth century, gives the composition explicity. It would appear that fireworks preceded fire-arms, as we have the undoubted description of a rocket by the same writer. To this author we are indebted for receipts for making the skin incombustible so that we may handle fire without being burnt. These doubtless were received as explanations of the legends of the time which related how miracle-workers had washed their hands in melted copper, and sat at their ease in burning straw. The definition of alchemy by some of the old Saracen chemists is very striking: the science of the balance, the science of weight, the science of combustion.

"To one of these cultivators of alchemy, Djafar, who lived toward the end of the eighth century, our attention may for a moment be drawn. He is the first to describe nitric acid and aqua regia. Before him no stronger acid was known than concentrated vinegar. (Cleopatra and the pearl dissolved in vinegar).

"His doctrine respecting the nature of metals, though erroneous, was not without a scientific value. A metal he considers to be a compound of sulphur, mercury, and arsenic, and hence he infers that transmutation is possible by varying the proportions of those ingredients. He knows that a metal, when calcined, increases in weight. . . . He describes the operation of distillation, sublimation, filtration, various chemical apparatus, water-baths, sand-baths, cupels of bone earth, of the use of which he gives a singularly clear description. A chemist reads with interest Djafar's antique method of obtaining nitric acid by distilling in a retort Cyprus vitriol, alum, and saltpetre. He sets forth its corrosive power, and shows how it may be made to dissolve even gold itself, by adding a portion of sal-ammoniac. Djafar may thus be considered as having solved the grand alchemical problem of obtaining gold in a potable state; and there can be no doubt but many trials

* Delivered at the Royal Institution, May 19th, 1906.

were made on the influence of this solution on the animal system.

"With Djafar may be mentioned Rhazes, born A.D. 860, physician in chief to the great hospital at Bagdad. To him is due the first description of the preparation and properties of sulphuric acid. He obtained it as the Nordhausen variety is still made, by the distillation of dried green vitriol. To him also are due the first indications of the preparation of absolute alcohol, by distilling spirits of wine from quicklime. As a curious discovery made by the Saracens may be mentioned the experiment of Achild Bechil, who, by distilling together the extract of urine, clay, lime, and powdered charcoal, obtained an artificial carbuncle, which shone in the dark 'like a good moon.' This was phosphorus. . . .

"The pursuit of the elixir made a well-marked impression upon Arab experimental science, confirming it in its medical application. At the foundation of this application lay the principle that it is possible to relieve the diseases of the human body by purely material means. As the science advanced it gradually shook off its fetichisms, the spiritual receding into insignificance, the material coming into bolder relief. Not, however, without great difficulty was a way forced for the great doctrine that the influence of substances on the constitution of man is altogether of a material kind, and not at all due to any indwelling or animating spirit; that it is of no kind of use to practise incantations over drugs, or to repeat prayers over the mortar in which medicines are being compounded, since the effect will be the same whether such has been done or not; and there is no kind of efficacy in amulets, no virtue in charms."

*The Sceptical Chymist, or Chemico-Physical Doubts and Paradoxes touching the Experiments whereby vulgar Spagyrists are wont to endeavour to evince their Salt, Sulphur, and Mercury, to be the true Principles of Things.* (Oxford, 1661).

"To be short, as the difference of bodies may depend merely upon that of the schemes, whereinto their common matter is put; so the seeds of things, the fire and the other agents are able to alter the minute parts of a body (either by breaking them into smaller ones of differing shapes, or by uniting together these fragments with the unbroken corpuscles, or such corpuscles among themselves) and the same agents, partly by altering the shape or bigness of the constituent corpuscles of a body, partly by driving away some of them, partly by blending others with them, and partly by some new manner of connecting them, may give the whole portion of matter a new texture of its minute parts, and thereby make it deserve a new and distinct name. So that, according as the small parts of matter recede from each other, or work upon each other, or are connected together after this or that determinate manner, a body of this or that denomination is produced, as some other body happens thereby to be altered or destroyed.

"Since then, those things, which chymists produce by the help of the fire, are but inanimate bodies; since such fruits of the chymist's skill differ from one another but in so few qualities, that we see plainly, that by fire, and other agents we can employ, we can easily enough work as great alterations upon matter, as those that are requisite to change one of these chymical productions into another; since the same portion of matter may, without being compounded with any extraneous body, or at least, element, be made to put on such a variety of forms, and consequently to be (successively) turned into so many differing bodies; and since the matter, clothed with so many differing forms, was originally but water, and that in its passage through so many transformations, it was never reduced into any of those substances, which are reputed to be the principles or elements of mixt bodies, except the violence of the fire, which itself divides not bodies into perfectly simple or elementary substances, but into new compounds; since, I say, these things are so, I see not, why we must needs believe, that there are any primogeneal and simple bodies, of which, as of pre-existent elements, nature is obliged to compound all others. Nor do I see, why we may not conceive that she may produce the bodies accounted mixt out of one another, by variously altering and contriving their minute parts, without resolving the matter into any such simple or homogeneous substances, as are pretended. Neither, to dispatch, do I see, why it should be counted absurd to think, that when a body is resolved by the fire into its supposed simple ingredients, those substances, are not true and proper elements, but rather were, as it were, accidentally produced by the fire, which by dissipating a body into minute parts does, if those parts be shut up in close vessels, for the most part necessarily bring them to associate themselves after another manner than before, and so bring them into bodies of such different consistences, as the former texture of the body and concurrent circumstances make such disbanded particles apt to constitute; as experience shows us (and I have both noted it, and proved it already) that as there are some concretes whose parts, when dissipated by fire, are fitted to be put into such schemes of matter as we call oil, and salt, and spirit; so there are others, such as are especially the greatest part of the minerals, whose corpuscles being of another size or figure, or perhaps contrived another way, will not in the fire yield bodies of the like consistences, but rather others of differing textures; not to mention, that from gold and some other bodies, we see not, that the fire separates any distinct substances at all; nor that even those similar parts of bodies, which the chymists obtain by the fire, are the elements, whose names they bear, but compound bodies, upon which, for their resemblance to them in consistence, or some other obvious quality, chymists have been pleased to bestow such appellations."

*Sir Isaac Newton as an Alchemist.—Brewster.*

"During the four years, from 1683 to 1687, the period in which the "Principia" was composed, he never abandoned his chemical experiments.

"Dr. H. Newton, who was his amanuensis during that time, tells us that during six weeks in spring and autumn, he was so constantly occupied in his laboratory that he was scarcely out of it either night or day, that the fire in it was almost always burning, that it was well furnished with chemical materials and apparatus, and that the transmuting of metals was his chief design.

"The alchemy of Boyle, Newton, and Locke cannot be thus characterised. The ambition neither of wealth nor of praise prompted their studies, and we may safely say that a love of truth alone, a desire to make new discoveries in chemistry, and a wish to test the extraordinary pretensions of their predecessors and their contemporaries, were the only motives by which they were actuated. In so far as Newton's inquiries were limited to the transmutation and multiplication of metals, and even to the discovery of the universal tincture, we may find some apology for his researches; but we cannot understand how a mind of such power, and so nobly occupied with the abstractions of geometry, and the study of the material world, could stoop to be even the copyist of the most contemptible alchemical poetry, and the annotator of a work, the obvious production of a fool and a knave; such, however, was the taste of the century in which Newton lived; and when we denounce the mental epidemics of a past age, we may find some palliation of them in those of our own times.

"Leibnitz, his great rival, was also an alchemist. In his early life he was secretary to the Society of Rosicrucians at Nuremberg—a secret association which practised alchemy, and which existed in several of the larger towns in Germany. Leibnitz, however, soon renounced his faith in the mystic art, and, there is reason to believe, from one of Newton's letters to Locke, that he also had learned to have but little confidence even in the humbler department of the multiplication of metals."

*Explanation of Chemical Action and Elective Attraction.—Sir Isaac Newton.*

"Have not the small particles of bodies certain powers, virtues, or forces, by which they act at a distance, not only upon the rays of light for reflecting, refracting, and inflecting, but also upon one another, for producing a great part of the phenomena of nature? For it is well known that bodies act one upon another by the attractions of gravity, magnetism, and electricity; and these instances show the tenor and course of Nature, and make it not improbable but that there may be more attractive powers than these. For Nature is very consonant and conformable to herself. How these attractions may be performed I do not here consider. What I call attraction may be performed by impulse, or by some other means unknown to me. I use that word here to signify only in general any force by which bodies tend towards one another, whatsoever be the cause. For we must learn from the phenomena of Nature, what bodies attract one another, and what are the laws and properties of the attraction, before we inquire the cause by which the attraction is performed. The attractions of gravity, magnetism, and electricity, reach to very sensible distances, and so have been observed by vulgar eyes; and there may be others which reach to so small distances as hitherto to escape observation; and perhaps electrical attraction may reach to such small distances, even without being excited by friction.

"The parts of the homogeneal hard bodies which fully touch one another stick together very strongly; and for explaining how this may be, some have invented hooked atoms, and others tell us that bodies are glued together by Rest, that is, by an occult quality, or rather by nothing; and others that they stick together by conspiring motions, that is, by relative rest amongst themselves. I had rather infer from the cohesion that their particles attract one another by some force which in immediate contact is exceeding strong, at small distances performs the chemical operations above mentioned, and reaches not far from the particles with any sensible effect.

"Now the above-mentioned notions are so great and violent, as to show that in fermentations the particles of bodies which almost rest are put into new motions by a very potent principle, which acts upon them only when they approach one another, and causes them to meet and clash with great violence, and grow not with the motion, and dash one another into pieces, and vanish into air, and vapour, and flame."

*Dr. Watson, Professor of Chemistry at Cambridge, 1764, on Phlogiston.*

"Notwithstanding all that perhaps can be said upon this subject, I am sensible the reader will still be ready to ask, *What is phlogiston?* You do not surely expect that chemistry should be able to present you with a handful of phlogiston, separated from an inflammable body; you may just as reasonably demand a handful of magnetism, gravity, or electricity to be extracted from a magnetic, weighty, or electric body. There are powers in nature which cannot otherwise become the objects of sense, than by the effects they produce; and of this kind is phlogiston. But the following experiments will tend to render this perplexed subject somewhat more clear.

"If you take a piece of *sulphur* and set it on fire, it will burn entirely away, without leaving any ashes or yielding any soot. During the burning of the sulphur, a copious vapour, powerfully affecting the organs of sight and smell, is dispersed. Means have been invented for collecting this vapour, and it is found to be a very strong acid. The acid thus procured from the burning of sulphur, is incapable of being either burned by itself, or of contributing towards the support of fire in other bodies; the sulphur, from which it was procured was capable of both; there is a remarkable difference, then, between the acid procured from the sulphur, and the sulphur itself. The acid cannot be the only constituent part of sulphur; it is evident that *something* else must have entered into its composition, by which it was rendered capable of combustion. This something is, from its most remarkable property, that of rendering a body combustible, properly enough denominated the food of fire, the *inflammable principle, the phlogiston*. . . . This inflammable principle, or phlogiston, is not one thing in animals, another in vegetables, another in minerals; it is absolutely the same in them all. . . . This identity of phlogiston may be proved from a variety of decisive experiments; I will select a few, which may at the same time confirm what has been advanced concerning the constituent parts of sulphur.

"From the analysis or decomposition of sulphur effected by burning, we have concluded that the constituent parts of sulphur are two—an *acid* which may be collected, and an *inflammable principle*, which is dispersed. If the reader has yet acquired any real taste for chemical truths, he will wish to see this analysis confirmed by synthesis; that is, in common language, he will wish to see sulphur actually made by combining its acid with an inflammable principle. It seldom happens that chemists can reproduce the original bodies, though they combine together all the principles into which they have analysed them; . . . in the instance, however before us, the reproduction of the original substance will be found complete.

"As the inflammable principle cannot be obtained in a palpable form separate from all other bodies, the only method by which we can attempt to unite it with the acid of sulphur must be by presenting to that acid some substance in which it is contained. Charcoal is such a substance; and by distilling powdered charcoal and the acid of sulphur together, we can procure a true yellow sulphur, in nowise to be distinguished from common sulphur. This sulphur is formed from the union of the acid with the phlogiston of the charcoal; and the charcoal may by this means be so entirely robbed of its phlogiston, that it will be reduced to ashes, as if it had been burned. . . .

"I will in this place, by way of further illustration of the term phlogiston, add a word or two concerning the necessity of its union with a metallic earth, in order to constitute a metal. Lead, it has been observed, when melted in a strong fire, burns away like rotten wood; all its properties as a metal are destroyed, and it is reduced to ashes. If you expose the ashes of lead to a strong fire, they will melt; but the melted substance will not be a *metal*, it will be a yellow or orange coloured *glass*. If you pound the glass, and mix it with charcoal dust, or if you mix the ashes of the lead with charcoal dust, and expose either mixture to a melting heat, you will obtain not a *glass* but a metal, in weight, colour, consistency, and every other property the same as lead. The ashes of lead melted *without* charcoal become *glass*; the ashes of lead melted *with* charcoal become a *metal*. The charcoal, then, must have communicated *something* to the ashes of lead, by which they are changed from a glass to a metal. Charcoal consists but of two things—of ashes and of phlogiston; the ashes of charcoal, though united with the ashes of lead, would only produce glass; it must therefore be the other constituent part of charcoal, or phlogiston, which is communicated to the ashes of lead, and by an union with which the ashes are restored to their metallic form. The ashes of lead can never be restored to their metallic form without their being united with *some* matter containing phlogiston, and they may be reduced to their metallic form by being united with *any* substance containing phlogiston in a proper state, whether that substance be derived from the animal, vegetable, or mineral kingdom; and thence we conclude not only that phlogiston is a necessary part of a metal, but that phlogiston has an identity belonging to it, from whatever substance in nature it be extracted. And this assertion still becomes more general if we may believe that metallic ashes have been reduced to their metallic form, both by the solar rays and the electrical fire."

(To be continued).

## THE ELECTROLYTIC DEPOSITION OF ZINC, USING ROTATING ELECTRODES.*

By T. SLATER PRICE, D.Sc., and G. H. B. JUDGE.

Under ordinary conditions zinc cannot be quantitatively deposited from a pure solution of zinc sulphate, or from one containing a small proportion of free sulphuric acid. An examination of the literature shows that although various methods have been worked out, using rotating electrodes and solutions of zinc sulphate to which some foreign electrolyte, such as oxalic acid, sodium acetate, &c., has been added, only two investigators have endeavoured to deposit zinc from the pure solution of the sulphate. Denso (*Zeit. Elektrochem.*, 1903, ix., 463), using a very imperfect method of stirring the electrolyte, was unable to obtain good results, although he could satisfactorily deposit cadmium from slightly acid solutions of the sulphate. Kollock and Smith (*Journ. Am. Chem. Soc.*, 1905, xxvii., 1255) obtained quantitative results, even in the presence of free sulphuric acid, using a mercury cathode and rotating anode; we shall have occasion to refer to this later.

We have investigated the deposition of zinc from solutions of zinc sulphate, making use of a rotating cathode, and the present communication gives a summary of the results so far obtained.

The platinum electrodes used were similar to those described in F. Mollwo Perkin's "Practical Methods of Electrochemistry," p. 81; the sand blasted gauze cathode was 22 m.m. in diameter, and 40 m.m. long; the double ring of wire with baffle plates, forming the anode, was 40 m.m. in diameter. For rotating the cathode use has been made of the front hub of a bicycle. This was suggested to one of us by Mr. H. L. Heathcote, B.Sc., the chief chemist at Rudge-Whitworth, Ltd., and we have found that it works extremely well, and, moreover, has the advantage of being cheap. One end of the spindle is drilled to receive the cathode, which is fastened in position by means of a screw, as shown in Fig. 1; or the spindle may be fitted with a small chuck for holding the cathode. The other end of the spindle is fitted with a grooved pulley. In order to make connection with the source of current two spokes are soldered across the hub, the one being bent and connected with the negative leading wire. The ball bearings are lubricated with a mixture of graphite and oil. The whole arrangement is practically frictionless, and can be driven by means of a small motor which works with 4 to 6 volts, and only costs 8s. 6d. The drop in potential across the bearings varies from one half to one volt.

In working with rotating cathodes we have not found it convenient to use a beaker to hold the solution. After the electrolysis is finished it is not satisfactory to stop the cathode rotating in order to syphon off the electrolyte and at the same time run in distilled water till all the solution has been displaced. It often happens that a trace of metal is re-dissolved from the cathode. If the beaker is to be so wide that the syphon tube can be put down between it and the anode, the cathode being kept rotating, the volume of the solution becomes inconveniently large. An ordinary tap funnel, as shown in the figure, answers admirably in place of the beaker. The one we have used has a capacity of about 100 c.c., and the anode ring just fits into it. The suction caused by the rotating cathode continually draws up the liquid from the neck of the funnel just above the tap, so that the circulation of the electrolyte is complete. We have tested this by putting a little chloroform into the neck, and then water above it; on rotating the cathode all the chloroform was rapidly drawn up and mixed with the water.

In all our experiments the volume of the solution was 50 to 60 c.c., and during the electrolysis the mouth of the funnel was covered by means of a split cover glass; towards the end of the experiment the cover glass and the sides of the funnel were washed down with distilled water, and the current passed for a short time longer in order to make sure that deposition was complete. The cover glass was then removed, and the washing of the cathode commenced at the same time as the tap of the funnel was turned in order to let the solution run out. The washing was continued until the current had fallen to zero, the cathode continuously rotating meanwhile. The electrode was then washed with absolute alcohol, and dried at steam-heat. In all cases the cathode was silvered before deposition of the zinc upon it.

The first experiments were made without taking any precautions to keep the electrolyte cool. The solution of zinc sulphate does not conduct very well, and it was found that if the voltage used was high enough to give a current of 2 ampères at the commencement of the experiment, the deposit was very liable to be spongy. The method finally adopted was as follows:—At the commencement of the experiment the current used was 0·25 ampère, the voltage necessary being 4; after five minutes the current was raised to 0·5 ampère, the necessary voltage being 5 to

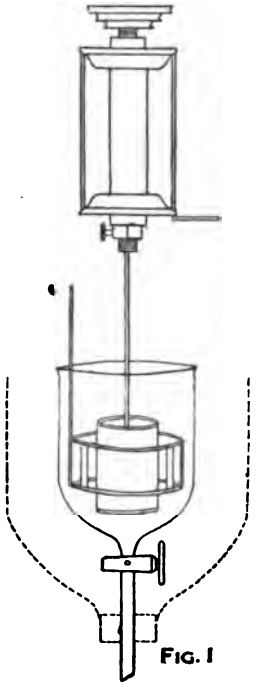


Fig. 1

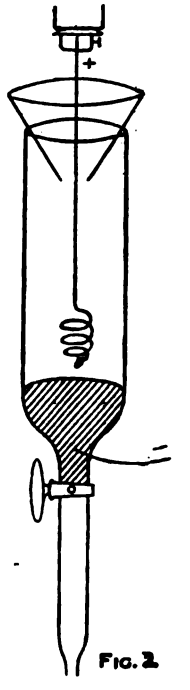



Fig. 2

5·5; after five more minutes the current was made equal to 1 ampère and the voltage was 6 to 6·5. If the apparatus was then left to itself the current gradually increased to 2 ampères (in about ten minutes), owing to the increase in conductivity, due partly to the liberation of sulphuric acid as the zinc is deposited, and partly to the heating effect of the current. The current was then kept at 2 ampères for twenty minutes (voltage finally 4·5 to 5·5), the cover glass and sides of the funnel being washed down about five minutes before the end of the experiment. The current could have been raised to 2 ampères in a shorter time than given above, but our object was not to cut down the time of deposition to a minimum, but rather to get a quantitative result.

The weight of zinc taken in each case was 0·2275 grm., and the weights of zinc deposited were 0·2257, 0·2251, 0·2258, 0·2249, grm. respectively. The deposit was very fine in appearance, of a light grey colour, and quite firm and adherent. In each case the solution was tested with ammonium sulphide, and no zinc could be detected. The results, although agreeing among themselves, were, how-

* A Paper read before the Faraday Society, June 12, 1906.

ever, uniformly low. It was afterwards found that the test with ammonium sulphide was not delicate enough, and that potassium ferrocyanide in hydrochloric acid solution must be used in its place. During the experiment the solution became quite warm, and it was possible that the low result was due to the increased solvent action of the free sulphuric acid on the deposited zinc (this statement is simpler than discussing the alteration with the temperature of the deposition potential of the zinc and hydrogen ions respectively). This was tested by increasing the current during the latter part of the experiment, the solution thereby being heated to a still higher temperature. With 4 ampères the weights of zinc deposited were 0·2230 and 0·2220 grm. respectively; with 5 ampères 0·2209 grm. The low result was evidently due to the heating effect of the current.

In the next experiments the electrolyte was kept cool by means of a jacket containing ice, as shown by the dotted lines in Fig. 1. The tap of the funnel could easily be turned by means of a glass rod, which hooked into a loop put on to one end of the tap.

The results obtained were very satisfactory. The weight of zinc taken in each case was 0·2274 grm. The weights found were 0·2274, 0·2266, 0·2271, 0·2260, 0·2274, 0·2268, 0·2273, 0·2273, 0·2272, 0·2269 grm. respectively. The temperature of the solution did not rise above 14° C.; the number of revolutions per minute of the cathode varied from 300 to 500, and in each case the deposit was very good. At the end of the experiment the normality of the solution with respect to sulphuric acid would be somewhere about N/20; it cannot be accurately given owing to the dilution on washing down.

It was even found possible to add a certain amount of sulphuric acid to the solution of zinc sulphate used, as shown by Table I. The normality of the solution with respect to sulphuric acid is that before the electrolysis was started. After washing down it would be diminished by about one-third, neglecting the acidity due to the sulphuric acid formed from the zinc sulphate. The first four experiments gave good results; in the last two the concentration of the acid was too great.

Instead of cooling with ice, cooling by means of a continuous flow of water through the outer vessel was tried, with the following results:—Weight of zinc taken was 0·2274 grm. The weights found were 0·2270, 0·2271, 0·2265, and 0·2261 grm. respectively. In the last two cases a specially made jacketted funnel was used, but it did not show any advantage over the arrangement shown in the diagram. The temperature in any of the four experiments did not rise above 17° C.

Table II. gives a series of results obtained when various salts were added to the solution of zinc sulphate. In each case the experiment was started with a low current, which was then gradually increased to 2 ampères; $t_1$ is the time in minutes taken to increase the current from 0·5 to 2 ampères, and $t_2$ the time the current was kept at 2 ampères. The solution was not cooled, and the weight of zinc taken in each case was 0·2274 grm.

The deposits were all that could be desired in every case where sodium sulphate was present, but where sodium acetate alone was added the deposit was liable to be spongy, and even if it was adherent, it was of a bad colour. The table shows that good results are obtained in the presence of 2 to 3 grms. of sodium sulphate, with or without sodium acetate, but that it is not advisable to have any free sulphuric acid present to start with. Exner (*Journ. Am. Chem. Soc.*, 1904, xxv., 896), Ingham (*Journ. Am. Chem. Soc.*, 1904, xxvi., 1269), and Fisher and Boddaert (*Zeit. Electrochem.*, 1904, x., 945), use sodium acetate (1 to 3 grms.) and acetic acid (0·2 c.c. of 30 per cent acid), and rotating anode; in the present case it is preferable to replace some or all of the sodium acetate by sodium sulphate, and the addition of acetic acid is unnecessary. Even with currents of 3 ampères, when the temperature rises to 45° C., good results are obtained in the presence of 2 grms. of sodium sulphate plus 1 grm. of sodium acetate.

TABLE I.

| Weight of zinc taken. Grm. | Normality of acid. | Weight of zinc found. Grm. | Error. Grm. |
|---|---|---|---|
| 0·2275 | n/15 | 0·2261 | −0·0014 |
| 0·2275 | n/15 | 0·2275 | 0·0000 |
| 0·2275 | n/7·5 | 0·2267 | −0·0008 |
| 0·2275 | n/6 | 0·2271 | −0·0004 |
| 0·2275 | n/4 | 0·2255 | −0·0020 |
| 0·2275 | n/3 | 0·2193 | −0·0082 |

TABLE II.

| Grms. of $Na_2SO_4$. | Grms. of sal. acetate. | C.c. of 2N $H_2SO_4$. | $t_1$. | $t_2$. | Volts. | Weight of Zn found. | Error. | Temperature of the solution rose to— |
|---|---|---|---|---|---|---|---|---|
| 1 | — | — | 10 | 19 | 3·5—6·8 | 0·2269 | −0·0005 | |
| 2 | — | — | 6 | 17 | 3—5·8 | 0·2274 | 0·0000 | 27° |
| 3 | — | — | 4 | 16 | 3·5—5·3 | 0·2277 | +0·0003 | |
| — | 1 | — | 11 | 19 | 4·5—8 | 0·2266 | −0·0008 | |
| — | 2 | — | 5 | 16 | 4—6·8 | 0·2276 | +0·0002 | |
| 2 | 1 | — | 7 | 13 | 3·5—5·8 | 0·2276 | +0·0002 | 28° |
| 3 | — | 5 | 5 | 17 | 3·5—4 | 0·2262 | −0·0012 | |
| 3 | — | 5 | 6 | 20 | 3·5—4·3 | 0·2259 | −0·0015 | |
| 3 | — | 5 | 6 | 11 | 3·8—4·5 | 0·2213 | −0·0061 | |
| 3 | — | 10 | — | 25 | 3·5—4 | 0·2187 | −0·0087 | |
| — | 3 | 5 | 5 | 19 | 4—6 | 0·2278 | +0·0004 | |
| 2 | 1 | 2 | 4 | 18 | 4·3—5·5 | 0·2262 | −0·0012 | 31° |
| 2 | 1 | 5 | 5 | 16 | 4·5—5 | 0·2235 | −0·0039 | |
| 2 | 1 | 5 | 4 | 20 | 4·3—5 | 0·2206 | −0·0068 | |
| 1 | 2 | 5 | 8 | 17 | 5—6 | 0·2250 | −0·0024 | |
| 2 | 2 | 5 | 6 | 18 | 3·8—5·5 | 0·2245 | −0·0029 | |
| (a) 2 | — | — | | | | 0·2252 | −0·0022 | 42° |
| (a) 2 | 1 | — | | | | 0·2278 | +0·0004 | 45° |

(a) In these two cases the current was allowed to rise to 3 ampères.

TABLE III.

| Zinc present. Grm. | Concentrated $H_2SO_4$ added. 40 drops=3 c.c. | Time, in mins. | Zinc found. | Error. |
|---|---|---|---|---|
| 0·2234 | 7 | 20 | 0·2008 | −0·0226 |
| 0·2234 | 7 | 10 | 0·2173 | −0·0061 |
| 0·2234 | 7 | 5 | 0·2200 | −0·0034 |
| 0·2234 | 6 | 10 | 0·2202 | −0·0032 |
| 0·2234 | 6 | 8 | 0·2202 | −0·0032 |
| 0·2316 | 4 | 8 | 0·2279 | −0·0037 |
| 0·2316 | 3 | 8 | 0·2288 | −0·0028 |
| 0·2316 | 2 | 8 | 0·2317 | +0·0001 |
| 0·2316 | 2 | 8 | 0·2318 | +0·0002 |
| 0·2316 | 2 | 8 | 0·2304 | −0·0012 |
| 0·2316 | 2 | 5 | 0·2246 | −0·0070 |
| 0·3353 | 2 | 10 | 0·3351 | −0·0002 |
| 0·3353 | 2 | 10 | 0·3347 | −0·0006 |
| 0·2316 | — | 5 | 0·2288 | −0·0028 |

Further experiments on the deposition of zinc, using the above apparatus, are being carried out in this laboratory, the results of which we hope to communicate later to the Society.

Kollock and Smith's method (*Journ. Am. Chem. Soc.*, 1905, xxvii., 1255) for the determination of zinc, using a mercury cathode and a rotating anode, is a very good one, but we think that the modification of the apparatus shown in Fig. 2 makes it more convenient. According to the original paper the mercury and the zinc amalgam are both dried and weighed in the glass tube which is used for the deposition. In our experiments the mercury was weighed in a porcelain crucible, put into the electrolysis tube, and at the end of the experiment the amalgam was run off into

the crucible through the tap; it is even possible to obtain the amalgam dry in this manner, although it is not advisable to neglect washing it with alcohol and ether. It is not absolutely necessary to syphon off the electrolyte and replace it by distilled water before running off the amalgam, although this latter procedure would tend to greater accuracy, obviating any carelessness in tapping off the amalgam. The figures given in Table III. were obtained in this way, *i.e.*, without syphoning off the electrolyte. They show, moreover, that it is necessary not to exceed a certain amount of free sulphuric acid, although Kollock and Smith do not mention this in their paper in the case of zinc. In each case the volume of the solution used was 10 c.c., and the current employed 5 ampères, requiring a voltage of 7.

Thus accurate results were obtained when not more than 2 drops (40 drops = 3 c.c.) of concentrated sulphuric acid were used in the presence of 0·2316 to 0·3353 grm. of zinc, the time of deposition being eight to ten minutes.

## ELECTRO-CHEMICAL CALCULATIONS.*

By JOSEPH W. RICHARDS.

(Continued from p. 7).

### Voltage Drop at the Electrode Surfaces.

This is the loss of potential across the electrodes corresponding to the work done at the electrodes. It is practically determinable by measuring the total potential drop, and subtracting from it the drop due to overcoming the ohmic resistance of the electrolyte. Calling V the total drop of potential, and $V^d$ that part of it absorbed in chemical (or physical) work at the surface of the electrodes, then—

$$V^d = V - V^c .$$

If $V^c$ has been determined in the manner described in the last paragraph, or has been calculated from the specific resistance of the electrolyte, properly determined, and the resistance capacity of the electrolytic vessel, then $V^d$ represents accurately the voltage drop due to all phenomena occurring *at the surface* of the electrodes, as distinguished from the mere phenomenon of electric conduction, ruled absolutely by Ohm's law, occurring *in the body* of the electrolyte.

It may not be amiss to remark, *en passant*, that the fact that Ohm's law applies absolutely to the conduction of electricity through the body of an electrolyte, in the same manner as in a metallic conductor, combined with Prof. Hopkins's recent determinations that the conducting of the current is practically instantaneous in electrolytes, as it is in solids, and that the body of an electrolytic conductor acts in all respects magnetically, &c., exactly the same as the body of a metallic conductor—all prove the identity of the mechanism of electric conduction through the substance or body of an electrolytic conductor and through solid metallic conductors. The phenomena at the bounding surfaces, the electrodes, are different in the two cases, but there is no experimental evidence of any dissimilarity in the mechanism of the conduction in the body of the conductors in the two cases.

### Transfer Resistance.

This is supposed to represent resistance to the passage of the current from the electrolyte to the electrode, of the nature of the work done when current is passed across a thermo-electric junction; that is, it is a resistance purely physical in its nature, existing simply because the current passes from one conducting substance to another one, and, finally, a resistance which causes the current to either generate heat, by heating this junction, or to absorb heat, by cooling the junction. It is therefore a reversible phenomenon, either subtracting potential from the current in such quantity as that the heat thus generated represents the heat equivalent of the watts thus lost, or else contributing potential to the circuit in such quantity that the potential thus furnished represents, when multiplied by the ampères flowing, the watt equivalent of the heat energy absorbed.

In your lecturer's opinion, this transfer resistance must be very small. Since it would be of different signs at the two electrodes, absorbing voltage at one and generating nearly an equal amount at the other, the difference between two quantities in themselves small, must be of a low order of magnitude. Further, no reliable determinations are at hand concerning these + and − thermo-electrical potentials, because of the inevitable complication of the measurements by purely chemical changes. For instance, one investigator kept two zinc electrodes in zinc-chloride solution, but at 20° C. difference of temperature, and measured the difference of voltage, calling it thermo-electric difference of potential; but aside from the fact that this ignores any thermo-electric difference of potential between the hot and the cold solutions or in any part of the external circuit, it is certain that it ignores the difference between the heat of formation of zinc chloride in aqueous solution at two temperatures 20° apart, which might easily be equal to the whole potential difference noted. Until, therefore, physicists have cleared up satisfactorily this whole subject of thermo-electric potential between electrodes and solutions, we are making a less error in leaving out its consideration than in trying to account and allow for it—particularly since we know that some of the so-called allowances are certainly erroneous.

I have left out of the definition of transfer resistance that produced by a change in the electrode whereby a film of insoluble salt or gas is produced and so chokes off the current. Such action is polarisation, and such change in the original conditions, practically introducing modified or even new electrode surfaces, is not transfer resistance, properly speaking.

### Voltage Required for Chemical Work.

We arrive here at the kernel of electrolytic calculation, the sole and sufficient basis being that the amount of electrical energy expended in doing chemical work must equal the energy equivalent of the chemical work done. If that position does not hold in this question, then energy could be created or lost, and the principle of the conservation of energy violated. We must admit, however, that if an electrolytic cell cools off while the current is passing, that external heat energy is being supplied which will diminish, by the amount so supplied, the work being done by the current. However, that quantity is in the nature of a possible correction, while the heat of the chemical reaction produced is the principal factor.

We must remark at the outset that the chemical work done means the whole change from the system before electrolysis to the system after electrolysis. There is no division of the chemical work of the current into that required for assumed primary reactions and that for assumed secondary reactions. Only changes taking place at the surface of the electrodes, however, affect the energy requirements; chemical reactions taking place away from immediate contact with the surface of the electrodes neither absorb energy from the circuit nor deliver energy to it,—they are purely incidental and independent chemical phenomena.

Knowing that 96,540 coulombs set free one chemical equivalent weight in grms. of an element, or decompose one chemically equivalent weight in grms. of a substance, or, in more general terms, reduce by one valency atomic weight of any chemically basic element, or increase by one valency atomic or molecular weight of any chemically acid element or radical,—we can soon foot up the chemical energy of the change produced. The thermochemical heat absorbed in the separation of a chemical equivalent weight of an element is the energy required to isolate it; and since the passage of 96,540 coulombs produce that

*Journal Franklin Institute*, February and March, 1906.

change, the voltage drop must be such that the calculated heat equivalent of the electric energy expended—

$$96{,}540 \times \text{voltage drop} \times 0{\cdot}2385$$

is equal to the thermochemical heat absorbed (Q for 1 equivalent). The voltage drop for the decomposition ($V^d$) must therefore be—

$$\text{Voltage drop} = \frac{\text{Q for 1 equivalent}}{23{,}040}.$$

These calculations have been made and verified by experiment on many chemical compounds. There are some few exceptions, but many such have subsequently been shown to be only apparent exceptions, the real reaction occurring during electrolysis not having been exactly understood, or else the thermochemical data not applying strictly to the conditions under which electrolysis took place.

(To be continued).

# PROCEEDINGS OF SOCIETIES.

## CHEMICAL SOCIETY.

*Ordinary Meeting, June 21st, 1906.*

Prof. R. MELDOLA, F.R.S., President, in the Chair.

(Concluded from p. 9).

131. "*Improved Apparatus for the Determination of Molecular Weights.*" By PHILIP BLACKMAN.

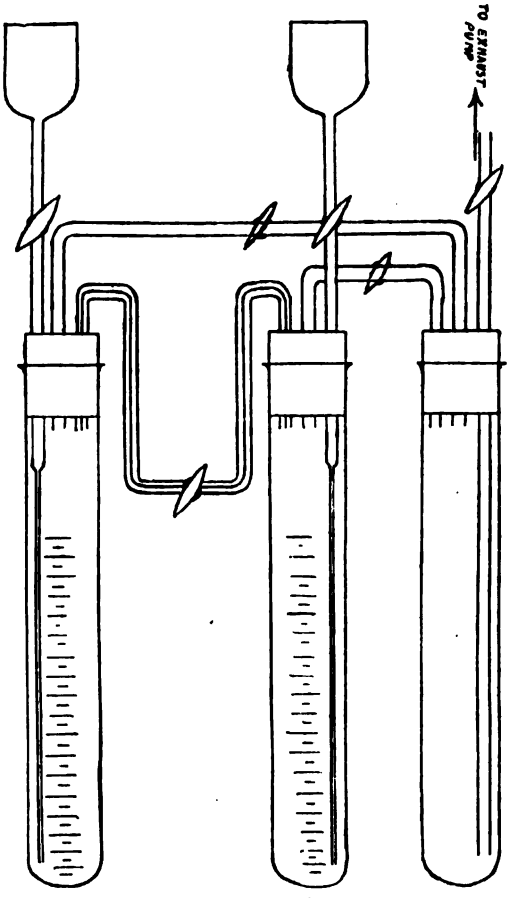
Isotonic solutions of two substances in the same solvent have equal vapour pressures at the same temperature. The state of equilibrium is represented by the equation :—

$$\frac{m_1}{m_2} = \frac{w_1}{w_2} \cdot \frac{v_2}{v_1}$$

($w_1$, $w_2$ are the weights of the substances of molecular weights $m_1$, $m_2$, dissolved in the solvent of volumes $v_1$, $v_2$ respectively). If two such solutions, maintained at the same temperature, have their vapours in communication by means of a suitable gauge, the indicator will remain stationary.

Unlike the previous method described by the author (*Trans.*, 1905, lxxxvii., 1474; *Proc.*, 1905, xxi., 304), the success of which depends entirely on the regularity with which the solutions can be made to boil, the new method is free from this difficulty.

Two graduated boiling tubes, and another similar ungraduated tube, are each fitted with a three-holed rubber stopper; through each stopper of the graduated tubes passes a glass-stoppered dropping funnel, the lower end of which is drawn out to a fine point which reaches to the bottom of the tube (a piece of glass tubing, drawn out to a point, may also be fixed by a rubber connection to the end of the funnel just below the stopper). The two graduated boiling tubes are connected by a gauge fitted with a tap, a suitable liquid which is not affected by the vapour of the solvent being used as indicator. These two tubes are connected with the third tube by means of inverted U-pieces, also fitted with taps. The third tube is furnished with a glass-stoppered tube. The three tubes should be arranged in the form of a triangle, so that the apparatus is self-supporting (see figure).




By using equal weights of the substances whose molecular weights are to be compared, the calculations are considerably simplified; the above equation, by making $w_1 = w_2$, becomes $m_1/m_2 = v_2/v_1$.

| Substances. (Those marked with asterisks * were set as tests). | | Ratio $m_1/m_2$. Theoretical. | Found. |
|---|---|---|---|
| *p*-Dibromobenzene ($= m_1$) | *p*-Chloronitrobenzene ($= m_2$) | 1·50 | 1·48 |
| Bromo-α-naphthol ($= m_1$) | *p*-Chloronitrobenzene ($= m_2$) | 1·42* | 1·41 |
| Bromo-α-naphthol ($= m_1$) | 1-Chloro-2 : 4-dinitrobenzene | 1·10* | 1·13 |
| Picric acid ($= m_1$) | 1-Chloro-2 : 4-dinitrobenzene | 1·13 | 1·12 |
| 2 : 4-Dinitrotoluene ($= m_2$) | *p*-Dibromobenzene ($= m_1$) | 1·30* | 1·32 |
| 2 : 4-Dinitrotoluene ($= m_1$) | α-Naphthylamine ($= m_2$) | 1·27* | 1·25 |
| *p*-Chloroaniline ($= m_2$) | 1-Chloro-2 : 4-dinitrobenzene | 1·59* | 1·55 |
| *p*-Chloroaniline ($= m_2$) | *p*-Nitroaniline ($= m_1$) | 1·08* | 1·09 |
| Iodoform ($= m_1$) | Hydrazobenzene ($= m_2$) | 2·14 | 2·09 |
| Hydrazobenzene ($= m_2$) | 1-Bromo-2 : 4-dinitrobenzene | 1·34 | 1·35 |
| 1-Bromo-2 : 4-dinitrobenzene | Diphenylamine ($= m_2$) | 1·46 | 1·50 |
| β-Naphthylamine ($= m_2$) | Picric acid ($= m_1$) | 1·60 | 1·59 |
| *p*-Chloroaniline ($= m_2$) | β-Naphthylamine | 1·12* | 1·19 |
| *p*-Toluidine ($= m_2$) | α-Naphthylamine ($= m_1$) | 1·33 | 1·34 |
| *m*-Dinitrobenzene ($= m_1$) | *p*-Nitrotoluene ($= m_2$) | 1·22 | 1·21 |

The weighed quantities of the two substances (about 0·1—0·5 grm.) are introduced into the graduated boiling tubes, the stoppers fixed in position, and the necessary connections effected. The taps in the funnels and gauge are kept closed, those in the U-tubes and remaining tube being left open; a little of the solvent is added to the funnels to ensure that no air may find its way into the apparatus. The third tube is then connected, by means of the stoppered tube, with a pump, and as high a vacuum as possible is obtained, after which the taps in the inverted U-pieces are closed. The solvent is now added from the funnels, care being taken to avoid the introduction of air. The solvent must be added in sufficient quantity to cover the lower ends of the funnels. The substances must be left to dissolve, the process being hastened by slightly agitating the apparatus; this also assists in producing uniformity of concentration. The tap in the gauge is cautiously opened (if care is not taken, the liquid serving as index may be forced into one of the solutions), and the movement of the indicator observed. This moves towards the tube in which the vapour pressure is smaller; consequently, if the solvent is added drop by drop from the funnel to that tube, a stage is reached at which the indicator remains stationary. Equilibrium having been attained, the volumes of the solutions are read off. More liquid may now be added to one of the solutions, and equilibrium re-established by the addition of solvent to the other, when another reading of the volumes is taken. This process is repeated as often as is desirable.

It may be advantageous to maintain the solutions at equal temperatures by standing the apparatus in a trough of water.

The accompanying table shows the results which were obtained. Equal weights of the substances were used in each experiment, the solvent was ether, and concentrated sulphuric acid was used as the index.

(We are indebted to the author for permission to insert the woodcut illustrating this paper).

## PHYSICAL SOCIETY.

*Ordinary Meeting, June 22nd, 1906.*

Prof. J. Perry, F.R.S., President, in the Chair.

A paper on "*The Effect of Radium in Facilitating the Visible Electric Discharge* in vacuo" was read by Mr. A. A. Campbell Swinton.

It has been shown by Edison, Fleming, and others, that the passage of the electric discharge *in vacuo* is much facilitated by heating the cathode. More recently, it has been shown that the passage of the discharge is still further facilitated by coating the heated cathode with oxides of the alkaline metals. It is generally held that the efficacy of the hot oxides in this direction is due to their giving off negatively-charged ions or corpuscles. The author therefore decided to ascertain whether similar effects could be obtained by painting the cathode with radium, and as radium gives off corpuscles when cold, it was anticipated that it might not be necessary to heat the cathode. Using a continuous current up to 400 volts pressure, this was found not to be the case, the radium having no appreciable effect in producing a visible discharge. When the radium-coated cathode was heated to redness, the radium was found to have a very marked action in facilitating the production of a luminous discharge. Experiments were made which proved that the mere presence of radium in the tube was insufficient to produce the effect, and, furthermore, it was found that the tube would only allow visible discharges to pass in the direction that made the radium-treated electrode the cathode, the tube acting as a unidirectional valve in the same way as do tubes with cathodes coated with oxides. Experiments were also made without any heating of the cathode, but using alternating currents of higher voltages than were available in continuous current. It was found that using an untreated electrode it required from 800 to 900 volts to get a visible discharge to pass; whereas, using a radium-treated electrode, a visible discharge could be got to pass with from 700 to 800 volts. The exact voltages required in each case were variable, but it was always found that a visible discharge could be got to pass, using the radium-treated electrode, with about 100 volts less than when the untreated electrode was employed. The phenomena with continuous currents, as described in the paper, were illustrated experimentally.

A paper on "*The Effect of the Electric Spark on the Actinity of Metals*" was read by Mr. T. A. Vaughton.

It has been pointed out by several observers that some metals, such as aluminium, cadmium, zinc, magnesium, &c., although not radio-active in the ordinary sense of the word, yet have the power of affecting a photographic plate. The electric spark has a remarkable influence on this "actinity," in some cases causing an increase, and in others apparently diminishing it. The alteration is not merely momentary but remains for months. It is, however, quite superficial, and may be removed by slightly rubbing the surface of the metal with emery-paper. In the case of aluminium sparked with gold, the direction of the current does not make much difference in the actinity of the sparked plate, but in the case of other couples the difference is very marked. For example, if a cadmium strip is sparked with antimony, the cadmium being connected with the positive terminal, the cadmium becomes very active photographically, not only on the spot sparked but all over its surface. If, however, the cadmium is connected with the negative terminal and sparked with a positive terminal of antimony, the cadmium remains very slightly more active than if not sparked at all. In order to compare the effect of the spark on the "actinity" of various metals, plates of the following fifteen elements were prepared:—Magnesium, aluminium, iron, cobalt, nickel, copper, zinc, silver, cadmium, tin, antimony, platinum, gold, lead, and bismuth. Each plate was sparked with a terminal of each of the fifteen metals in the order of their atomic weights. After sparking, the plate was placed on a sensitive bromide plate, and left in the darkness for a month. It was found that in the case of Al, Ni, Mg, and Sn the sparked spots were more active than the rest of the plate; but with Zn, Cd, Pb, and Bi the spots are not so active as the rest of the plate—probably resulting from an opaque film of oxide produced at the sparking-point. The penetrating power of the rays emitted from sparked metals varies considerably, and is investigated in the paper. The author points out that it is interesting to note that most of the greatest increases in actinity, caused by sparking, are produced in sparking together two metals the sum of whose atomic weights approaches that of a radio-active element, thus suggesting a synthesis of these elements.

A paper on "*The Dielectric Strength of Thin Liquid Films*" was read by Dr. P. E. Shaw.

The range of voltage used in the experiments is from 25 to 400, and the corresponding spark-lengths vary from about 0·15 $\mu$ to 6·0 $\mu$ ($\mu$ = 0·001 m.m.) for the insulating liquids used. The apparatus employed for measuring length is the micrometer designed by the author for measuring gauges (*Proc. Roy. Soc.*, April, 1906). On each micrometer-screw a cap is fitted—one cap terminates in a disc of iridio-platinum, and the other in a sphere or portion of a sphere of iridio-platinum. Discharge occurs between the two iridio-platinum surfaces, a drop of the insulating liquid being placed between them. Voltage is registered by a voltmeter, and is obtained by passing an electric-lighting current through a liquid resistance, and taking whatever fraction of the voltage is required. Two circuits are used, one of very low voltage, say, $\frac{1}{20}$ volt, to determine the contact position for the surfaces, and the other to give the high voltage required for sparking. The substances used were olive oil, castor oil, linseed oil, rape oil, turpentine, fusel oil, oil of resin, cod-liver oil, neat's-foot oil, paraffin, transformer oil, the homologous series $C_5H_{12}$, $C_6H_{14}$, $C_7H_{16}$, $C_8H_{18}$, and armacell, ohmaline, and Sterling

varnishes. The best insulators are paraffin and transformer oil, though for these, as for all commercial oils, great care was taken to remove water and acid by prolonged heating to 110° C., and treating with potassium carbonate. Generally speaking, the curves connecting voltage and spark-length are roughly straight to the origin, the gradient varying between 110 volts per micron and 70 volts per micron. Distinct local variations in gradient are found in one or two cases, *e.g.*, castor oil, olive oil, and paraffin. The air-curve is cut by the oil-curves at voltage 300; for less voltage air has greater dielectric strength, but at that voltage air suddenly weakens, and for greater voltages all oils are stronger. No simple connection can be traced between specific inductive capacity and dielectric strength.

Mr. A. Russell considered the method of research a valuable one. He doubted, however, whether the results obtained would be much help in determining the relative values of the "dielectric strengths" of thin films of insulating materials. The numbers given in the paper only refer to thin films between iridio-platinum electrodes. Hobbs has shown that for small distances the sparking potentials are practically independent of the nature of the gas between the electrodes. They depend mainly upon the metal of which the electrodes are made. At these microscopic distances, owing to the corpuscles, the electrostatic field between them was far from uniform. The disruptive voltage for a film of air one micron thick, if it could be subjected to a uniform electrostatic stress, would only be about 3·8 volts. When liquids were introduced between the electrodes, it was extremely difficult to determine the maximum electric intensity at the instant of discharge, as they had a different dielectric coefficient from air, and so there would be refraction of the Faraday tubes.

Dr. Shaw, in reply to Mr. Russell, said that the air-curve mentioned was that for iridio-platinum, and was obtained by a distinct set of experiments on air. The gradient was steeper than any found by Hobbs in his recent work. As regards the use of the term "dielectric strength," Dr. Shaw used it in its common sense as a general term implying strength to resist discharge, and no numerical value was given to it in the paper.

A paper on "*The Effect of Electrical Oscillations on Iron in a Magnetic Field*" was read by Dr. W. H. Eccles.

In attempting to make precise measurements of the effect of high-frequency oscillations on iron held magnetised by a magnetic field, two main difficulties are met. The one is that arising from the fact that the oscillatory currents induced on the surface of the iron investigated shield the inner layers, and thus make the mass of iron affected a variable quantity. The other difficulty arises in the matter of producing oscillations of determinate and invariable character. The author has endeavoured to meet the first difficulty by using oscillations so feeble that they affected only the outermost layers of the iron wires employed, and these even only slightly. The second difficulty has been met by using the oscillations produced in an open insulated solenoid by a single small measurable spark passed to one end of the solenoid.

In the experiments, soft iron was taken a large number of times round any chosen magnetic cycle till what may be called a cyclic state was attained. The field was then given any desired value, and the iron submitted to a train of oscillations. The consequent alteration in pole-strength was observed by the deflection of a magnetometer-mirror. These processes were all repeated a number of times for each selected point of the cyclic curve. The apparatus used consisted of two straight solenoids placed horizontally on one and the same magnetic east-west line on either side of the magnetometer. They were connected in series with cells, rheostats, measuring-instruments, &c. The coil in which the oscillations were generated was inside the east solenoid, but well insulated from it; one end was free, and the other was connected to one side of a micrometer spark-gap. The sparks were produced by a diminutive influence-machine, and were usually half a millimetre in length. After arranging the two empty solenoids in compensating position, equal amounts of iron wire were introduced into them, and adjusted till only trifling magnetometer deflections accompanied the rise and fall of the solenoid current. The magnetometer control field could then be greatly diminished. Of course the iron in the east solenoid lay within the oscillation-coil described above. Thus, when a spark passed, the small change in the magnetic state of the east iron could be measured.

The tables of results and the diagrams from them show that the change of pole-strength produced by a spark was, at any point of a cycle, always such as to move the representative point on the IH diagram towards the centre-line of the hysteresis loop. They show, moreover, that in cycles of greater amplitude the oscillations have, on the whole, greater effects. In all cases the effects show some relation to the gradient, at the corresponding point, of the cyclic curve. In the paper the gradient curves are compared with the spark-effect curves, with the result that the spark-effect does not seem to be simply proportional to the gradient. In addition, observations on the result of varying the spark-gap are recorded. These point to the conclusion that the wastage, instigated by the oscillations, of the intrinsic energy of the magnetised material is, for certain initial voltages of the oscillations, proportional to the total energy of the oscillations.

Mr. A. Campbell expressed his interest in the paper, and asked for the magnitude of the change of pole-strength produced by the passage of a spark.

Mr. Walter congratulated the author upon the method of the research, and said that the precautions which had been taken rendered the results free from suspicion.

Dr. Eccles, in reply to Mr. Campbell, said that the deflections produced by the change in pole-strength consequent on the passage of a spark were about $\frac{1}{8}$ of the maximum deflections obtained in the hysteresis curves.

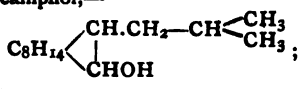
## CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

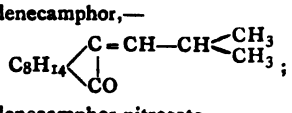
*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxlii., No. 24, June 12, 1906.

**Products of the Reaction of Sodium Isobutylate and Propylate on Camphor at a High Temperature.**—A. Haller and J. Minguin.—The authors investigate the various derivatives which are formed during the reaction of camphor on certain sodium alcoholates at a high temperature. He thus prepares—

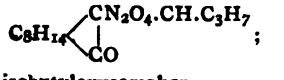
(1) Isobutylcamphol,—



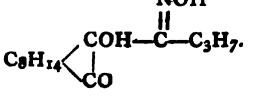
(2) Isobutylidenecamphor,—



(3) Isobutylidenecamphor nitrosate,—



(4) Isonitroso-isobutyloxycamphor,—



**Magnetic Properties of Boron and Manganese Compounds.**—Binet du Jassonneix.—The reduction of manganese oxides by boron in the electric furnace results in a mass containing a maximum of 28·6 per cent of boron and from which two definite borides, MnB and $MnB_2$, can be separated. These borides oxidise in air, and melt at a temperature too high to allow of examination *in vacuo*. Also the difficulty of obtaining them in ingots of convenient dimensions renders it only possible to study them in the form of powder. The author finds, however, that MnB is the only compound possessing magnetic properties, and the magnetic permeability of the borated melts of manganese is greater as it contains more of this boride.

**Iodomercurates of Magnesium and Manganese.**—A. Duboin.—In the same way as the author prepared the iodomercurates of the alkaline earths he now prepares iodomercurates of magnesium and manganese by dissolving alternately in a small quantity of water iodine and mercuric iodide, helping the solution towards the close of the operation by a slight elevation of temperature, and then adding the iodide of magnesium or manganese. The iodomercurate of magnesium is crystalline in large crystals having a density of 3·8 and a formula $MgI_2.2HgI_2.7H_2O$. A second crop of very deliquescent crystals of formula $MgI_2,HgI_2.9H_2O$ can also be obtained. The manganese salt has formula $HgI_2.1{\cdot}40MnI_2.10{\cdot}22H_2O$ and a density of 2·98, and after evaporation in dry air in presence of sulphuric acid a salt of density 3·8 and formula $3MnI_2.5HgI_2.20H_2O$ is obtained. In presence of water and other solvents these iodomercurates behave very much in the same manner as the calcium iodomercurates.

**Reduction of Antimony Selenide.**—P. Chrétien.—Antimony selenide may be completely reduced by hydrogen in the same manner as the sulphide, but the reaction is much slower. The author's investigations on this reaction and the fusibility curve of mixtures of antimony and selenium point to the existence of a number of sub-selenides, from which the author isolates the monoselenide, SbSe; the subselenide, $Sb_4Se_5$ or $Sb_2Se_3,2SbSe$; and the saline selenide, $Sb_3Se_4$ or $Sb_2Se_3.SbSe$.

**Bleaching of Linen.**—Léo Vignon and J. Mollard.—The authors investigate the action of gaseous chlorine, chlorine water, and chloride of lime on linen. The experiments are made under definite and different conditions, allowing for the chemical and physical modifications by each process afforded by the initial properties of linen. They find that chlorine when acting upon linen modifies it and is dissolved. The linen takes new properties on itself. In particular it loses 10 per cent of its weight, takes dyes easily, giving darker and more brilliant shades.

**Estimation of Albuminoid and Gelatinous Matter by means of Acetone.**—F. Bordas and M. Touplain.—The authors find that by using aqueous acetone, albuminoid and gelatinous substances are precipitated from solution. Acetone also separates from fats and oils of resin the soluble salts which they may contain, and this reaction takes place without lengthy previous desiccations.

## NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertisement columns.

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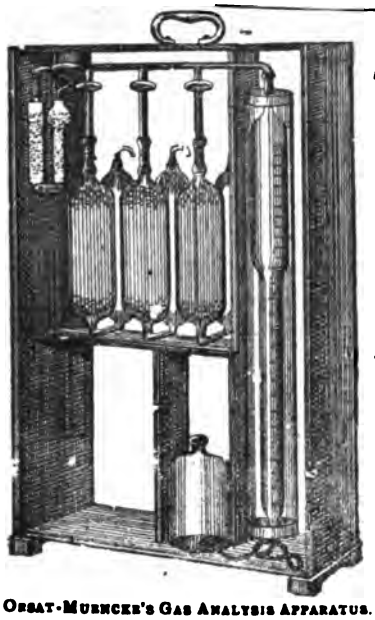

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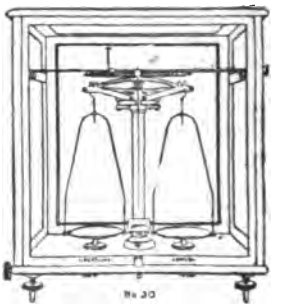

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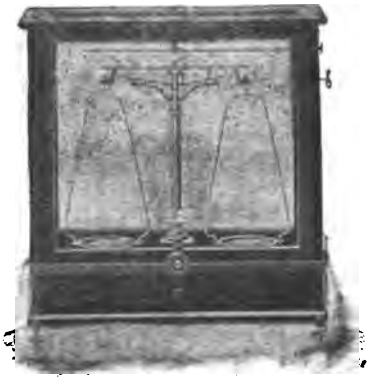

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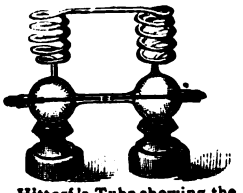

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THE CHEMICAL NEWS.

Vol. XCIV., No. 2434.

## NOTES OF A COURSE OF LECTURES ON THE OLD AND NEW CHEMISTRY.*

### I. Extracts from different Authors relating to the Old Chemistry.

By Prof. Sir JAMES DEWAR, F.R.S., &c.

(Continued from p. 17).

*The Revived Theory of Phlogiston.—Odling.*

"The foregoing account by Dr. Watson is almost a translation from Stahl's *Zymotechnica Fundamentalis, simulque experimentum novum sulphur verum arte producendi*, in which he establishes what may be called the permanency of chemical substance—that metallic lead is reproducible from the ashes of lead, *sulphur verum* from the acid of sulphur. And, whether or not taking note of the oxidations and deoxidations effected, how little differently, even at the present day, would the actions referred to be described and explained. Is it not our habit to say that charcoal and sulphur and lead are bodies possessing potential chemical energy, that is phlogiston; that in the act of burning, their energy which was potential becomes kinetic or dynamical, and is dissipated in the form of light and heat: that the products of their burning (including the gaseous product now known to be furnished by the burning of charcoal) are substances devoid of chemical energy, that is, of phlogiston: that when the acid substance furnished by burning sulphur is heated with charcoal, some energy of the unburnt charcoal is transferred to the burnt sulphur, just as some energy of a raised weight may be transferred to a fallen one, whereby the burnt sulphur is unburnt, provided with energy, and enabled to burn again, and the fallen weight is lifted up, provided with energy, and enabled to fall again; that the potential chemical energy of metallic lead did not originate in the lead, but is energy or phlogiston transferred thereto from the charcoal by which it was smelted; and lastly, that the chemical energy of the charcoal itself, its capability of burning, its power of doing work, in one word its phlogiston, is merely a portion of energy appropriated directly from the solar rays?

"If this be a correct interpretation of the phlogistic doctrine, it is evident that the Stahlians, though ignorant of much that has since become known, were nevertheless cognisant of much that became afterwards forgotten. For most of what has since become known, mankind are indebted to the surpassing genius of Lavoisier; but the truth which he established, alike with that which he subverted, is now recognisable as a partial truth only; and the merit of his generalisation is now perceived to consist in its addition to—its demerit to consist in its supersession of—the not less grand generalisation established by his scarcely remembered predecessors. This being so, the relationship to one another of the Stahlian and Lavoisierian theories of combustion furnishes an apt illustration of the general truth set forth by a great modern writer, that 'in the human mind, one-sidedness has always been the rule, and many-sidedness the exception. Hence, even in revolutions of opinion one part of the truth usually sets while another rises. Even progress, which ought to superadd, for the most part only substitutes one partial and incomplete truth for another; improvement consisting chiefly in this, that the new fragment of truth is more wanted, more adapted to the needs of the time, than that which it displaces.'"

* Delivered at the Royal Institution, May 19th, 1906.

Chaucer, 1340—1400.

For out of the olde fieldes, as men saithe
  Cometh all this new corn from yere to yere:
And out of olde Bookes in Goode faithe,
  Cometh all this new science that men lere.

Sir priest, he said, I keep, for to have no lose
Of my craft, for I would it were kept close;
And as you love me, kepith it secre,
For and men knowin all my subtilte,
By God men wouldin have so grete envie
To me, because of my Philosophie,
I should be dedde, there were none otherwaie.

I woll you tell as was me taught also
The four spirites and the bodies seven
By order as I herd my lord nemene.
  The first spirite quicke silvir clepid is,
The second Orpiment, the third iwis,
Sal Amoniake, and the fourth Brimstone.
The bodies seven, lo! here 'hem anone,
Sol gold is, and Luna silver we threpe,
Mars yron, Mercury quickesilver we clepe,
Saturnus leade, and Jupiter is tinne,
And Venus copir, by my fathir kinne.

*The Chanon Yeman's Tale.*

Luther, 1483—1546.

The upright art of Alchymie liketh me well.

Shakespeare, 1564—1616.

His countenance, like richest alchymy,
Will change to virtue, and to worthiness.

*Jul. Cæs.* i. 3.

To solemnize this day, the glorious sun
Stays in his course and plays the alchemist,
Turning, with splendour of his precious eye,
The meagre cloddy earth to glittering gold.

*K. John*, iii. 1.

Hence! pack! there's gold, ye came for gold, ye slaves:
You have done work for me, there's payment:
  Hence!
You are an alchymist, make gold of that:—
Out, rascal dogs!

*Timon*, v. 1.

Full many a glorious morning have I seen
Flatter the mountain-tops with sovereign eye,
Kissing with golden face the meadows green,
Gilding pale streams with heavenly alchemy;
* * * *

*Sonnet* 33.

Or whether shall I say, mine eye saith true,
And that your love taught it this alchemy,
To make of monsters and things indigest
Such cherubins as your sweet self resemble,
Creating every bad a perfect best,
As fast as objects to his beams assemble?

*Sonnet* 114.

"The Alchemist," Ben Jonson, 1574—1637.

Alchemy is a pretty kind of game,
Somewhat like tricks o' the cards to cheat a man
With charming.

  He honest wretch,
A notable superstitious good soul,
Has worn his knees bare, and his slippers bald,
With prayer and fasting for it. . . . Here he comes.—
Not a profane word afore him——— 'tis poison.

He will make Nature ashamed of her long sleep,
When art, who's but a step-dame, shall do more than she
In her best to love to mankind, ever could.
If his dream last he'll turn the Age to Gold.

*Sir Epicure Mammon.*

MILTON, 1608—1674.

So down they sat,
And to their viands fell; nor seemingly
The Angel, nor in mist, the common gloss
Of Theologians; but with keen despatch
Of real hunger, and concoctive heat
To transubstantiate: What redounds, transpires
Through Spirits with ease; nor wonder: if by fire
Of sooty coal the empirick alchemist
Can turn, or holds it possible to turn,
Metals of drossiest ore to perfect gold.

*Par. Lost*, b. v. 436—444.

"PARACELSUS," ROBERT BROWNING, 1812—1889.

Would I were sure to win
Some startling secret in their stead, a tincture
Of force to flush old age with youth, or breed
Gold, or imprison moonbeams till they change
To opal shafts!—Only that, hurling it
Indignant back, I might convince myself
My aims remained supreme and pure as ever!
Even now, why not desire, for mankind's sake,
That if I fail, some fault may be the cause,
That, thongh I sink, another may succeed?

For night is come,
And I betake myself to study again,
Till patient searchings after hidden lore
Half wring some bright truth from its prison; my frame
Trembles, my forehead's veins swell out, my hair
Tingles for triumph. Slow and sure the morn
Shall break on my pent room, and dwindling lamp,
And furnace dead, and scattered earths and ores;
When, with a failing heart and throbbing brow,
I must review my captured truth, sum up
Its value, trace what ends to what begins,
Its present power with its eventual bearings,
Latent affinities, the views it opens,
And its full length in perfecting my scheme.
I view it sternly circumscribed, cast down
From the high place my fond hopes yielded it,
Proved worthless—which, in getting, yet had cost
Another wrench to this fast-falling frame.
Then, quick, the cup to quaff, that chases sorrow!
I lapse back into youth, and take again
My fluttering pulse for evidence that God
Means good to me, will make my cause His own.

(To be continued).

## THE SOLUBILITY OF LEAD SULPHATE IN AMMONIUM ACETATE SOLUTIONS.*

By ARTHUR A. NOYES and WILLIAM H. WHITCOMB.

### I. *Hypotheses as to the Cause of the Solubility-increase.*

It is a well known fact, and one often made use of in chemical analysis, that lead sulphate, though difficultly soluble in water, dissolves in considerable quantity in a strong ammonium acetate solution. As to the magnitude of this solubility we have, however, been able to find only two quantitative statements, that of Long (*Am. Chem. Journ.*, 1899, xxii., 217), and that of Bischof (Comey's "Dictionary of Solubilities"), both of which relate to very concentrated solutions of ammonium acetate.

There has, moreover, been offered no verified explanation of the large increase in solubility which ammonium acetate produces. It seems, however, probable that the effect arises from one of the three following causes, or from a combination of them:—(1) Lead acetate is a slightly ionised substance, and therefore a large quantity of it is produced in the solution by metathesis; (2) intermediate cathions containing lead in combination with the acetate ion, $PbC_2H_3O_2+$, are formed; (3) complex cathions of the composition $Pb(NH_3)_x++$ are produced by combination of the lead ion with the free ammonia resulting from the hydrolysis of the salt.

These three hypotheses can be tested by migration experiments, for, in the first case, the lead, being present only as an un-ionised compound, would not move at all, while in the second or third case, it would migrate with the positive current. The first and second hypotheses can further be tested by determining the degree of ionisation of lead acetate and its change with the dilution by conductivity measurements or otherwise. Furthermore, both the first and second hypotheses evidently require that sodium acetate (or any other di-ionic acetate) have nearly the same effect on the solubility of lead sulphate as ammonium acetate, while, on the other hand, the third hypothesis would lead to the expectation that the sodium salt would have a much slighter effect. The third hypothesis may seem to be inconsistent with the fact that lead hydroxide is but little soluble in ammonium hydroxide, but it is not necessarily so, since in the latter solvent the hydroxyl-ion concentration may be large enough to keep down the concentration of the lead ion, and therefore that of the complex ion, if this were not very stable. This hypothesis would, however, evidently require that neutral ammonium acetate, owing to its greater hydrolysis, be a much better solvent for lead sulphate then neutral ammonium nitrate or chloride; that these different salts behave nearly alike if a moderate proportion of ammonium hydroxide be added to their solutions; and that the addition of acetic acid greatly reduce the solvent power of ammonium acetate. These last requirements seem, indeed, to be at variance with analytical experience.

### II. *Previous Measurements relating to the Subject.*

There already exists some evidence that lead acetate is much less ionised than other salts of the same type, and therefore that the first hypothesis furnishes the true explanation of the increase in the solubility of lead sulphate. Thus, the freezing-point measurements of Kahlenberg (*Zeit. Phys. Chem.*, 1895, xvii., 583) indicate an ionisation of only 19 per cent in ¼ molal, and of 37 per cent in ⅛ molal solution. Moreover, an isolated measurement of the conductance of the salt in 1/40 molal (1/20 normal) solution at 25° by Trey (*Zeit. Phys. Chem.*, 1897, xxii., 433) gave a value corresponding to an equivalent conductivity of 32·0 in reciprocal ohms or to a degree of ionisation of 28·4 per cent; and a series by Ley (*Zeit. Phys. Chem.*, 1899, xxx., 246) beginning with 1/30 normal gave at this concentration an equivalent conductivity of 37·6 reciprocal ohms corresponding to an ionisation of 33·4 per cent. Evidence against the third hypothesis is furnished also by the results of Dibbitts (*Dingler Polytech. Journ.*, ccx., 475; *Zeit. Anal. Chem.*, xiii., 137), who found that sodium acetate also increases greatly the solubility of lead sulphate; he found, namely, that 100 c.c. of a solution containing 2·05 grms. sodium acetate dissolves 0·054 grm. lead sulphate, and 100 c.c. of one containing 8·20 grms. sodium acetate dissolves 0·900 grm. lead sulphate.

The subject seemed, however, to deserve fuller investigation, and we have therefore done some further work upon it. This has consisted in qualitative migration experiments with solutions of lead sulphate in ammonium acetate, measurements of the conductivity of aqueous solutions of pure lead acetate, accurate determinations of the solubility of lead sulphate in ammonium acetate solutions, and a single rough one in a sodium acetate solution. It is the purpose of this article to present the results and discuss their significance.

### III. *Conductivity of Lead Acetate Solutions.*

The sample of lead acetate used in our experiments was prepared by crystallising the chemically pure commercial salt four times from hot water containing acetic acid, and

* From the *Journal of the American Chemical Society*, xxvii., No. 5.

once from pure water. It was dissolved in conductivity water, and the solution was standardised by precipitation with sulphuric acid and weighing the lead sulphate. Two solutions were so prepared at different times. The first contained 1·420 equivalents (0·710 mol.) per litre. The second contained 0·5088 equivalent (0·2544 mol.) per litre.

The measurements were made at 25° by the Kohlrausch method, using a resistance vessel of the Arrhenius type, the resistance capacity or cell-constant of which was determined by measurements with 0·01 normal potassium chloride solution. The results are all expressed in reciprocal ohms. The value of the equivalent conductivity ($\Lambda_0$) at infinite dilution (112·8) used in calculating the conductivity ratio ($\Lambda/\Lambda_0$), which corresponds to the degree of ionisation, if the salt dissociates only into Pb++ and Ac− ions, was calculated from the values for the individual ions at 18° given by Kohlrausch and Grüneisen (*Berliner Sitzungsber. d. Akad. d. Wissenschaften*, 1904, p. 1221), $\Lambda_{Pb}=61·1$ at 18°; and by Kohlrausch and Steinwehr (*Ibid.*, 1902, p. 587), $\Lambda_{Ac}=35·0$ at 18°; and from the temperature-coefficients computed by Kohlrausch (*Ibid.*, 1901, p. 1026; *Zeit. Phys. Chem.*, xliii., 511).

The first solution above referred to was diluted four times in succession with conductivity water by means of two graduated flasks in such a way that the concentration was each time reduced to one-fourth of its former value. The value of the cell-constant (or the factor by which the actual conductance must be multiplied to give the specific conductance) in this series of experiments was 0·1389.

A second series of measurements was carried out with greater care with the second solution, it being diluted in a somewhat different manner from the first. The stock solution was kept in a Jena flask, from which it was drawn as required, air being admitted through a soda-lime tube. Two-fold dilutions were made by weighing, the volume concentrations being calculated with the help of a specific gravity determination. The value of the cell-constant was 0·1400 in the case of the first two measurements of the series, 0·1243 in the other cases.

The results of the measurements are given in Table I.

TABLE I.—*Conductivity of Lead Acetate at 25°.*

| Equivalents per litre. | Actual conductance. | Equivalent conductivity. | Conductivity ratio × 100. |
|---|---|---|---|
| | *First Series.* | | |
| 0·3550 | 0·03457 | 13·50 | 12·0 |
| 0·0888 | 0·01627 | 25·38 | 22·5 |
| 0·0222 | 0·007035 | 43·74 | 38·8 |
| 0·00555 | 0·002790 | 68·75 | 60·9 |
| | *Second Series.* | | |
| 0·5088 | 0·04220 | 11·61 | — |
| — | 0·04209 | 11·58 | — |
| — | 0·04762 | 11·63 | — |
| — | 0·04772 | 11·66 | — |
| — | 0·04735 | 11·57 | — |
| — | 0·04770 | 11·65 | — |
| — | Mean | 11·62 | 10·3 |
| 0·2544 | 0·03345 | 16·34 | — |
| — | 0·03346 | 16·34 | — |
| — | 0·03345 | 16·34 | — |
| — | 0·03368 | 16·45 | — |
| — | 0·03361 | 16·42 | — |
| — | 0·03365 | 16·43 | — |
| — | Mean | 16·39 | 14·5 |
| 0·1272 | 0·02272 | 22·19 | — |
| — | 0·02274 | 22·21 | — |
| — | 0·02271 | 22·18 | — |
| — | Mean | 22·19 | 19·7 |

The mean values of the equivalent conductivity derived from these two independent series of experiments (after being corrected with help of the formula referred to just below, to a round dilution not differing much from that at which the measurements were made) and the above mentioned results of Trey and of Ley (expressed in reciprocal ohms instead of in mercury-units as given by those authors) are for the purpose of better comparison, summarised in Table II. The table also contains the corresponding value of the conductivity-ratio ($\Lambda/\Lambda_0=\gamma$) multiplied by 100, and the values of the empirical function $100(\gamma C)^2/C(1-\gamma)$, where C is the equivalent concentration, which function was found to be fairly constant when applied to our own data between ½ and 1/32-normal.

TABLE II.—*Summary of Equivalent Conductivity Values.*

| Litres per equivalent. | Equivalent conductivity. | Conductivity ratio × 100. | $\frac{100(\gamma)C^2}{(1-\gamma)C}$ |
|---|---|---|---|
| 2 | 11·73 | 10·4 | 0·6019 (*b*) |
| 3 | 13·99 | 12·4 | 0·5808 (*a*) |
| 4 | 16·47 | 14·6 | 0·6256 (*b*) |
| 8 | 22·45 | 19·9 | 0·6148 (*b*) |
| 12 | 26·05 | 23·1 | 0·5800 (*a*) |
| 20 | 32·00 | 28·4 | 0·5635 (*c*) |
| 32 | 37·63 | 33·4 | 0·5234 (*d*) |
| 48 | 44·89 | 39·8 | 0·5461 (*a*) |
| 64 | 46·98 | 41·7 | 0·4662 (*d*) |
| 128 | 57·40 | 50·9 | 0·4121 (*d*) |
| 192 | 69·94 | 62·0 | 0·5264 (*a*) |
| 256 | 68·23 | 60·5 | 0·3623 (*d*) |
| 512 | 79·09 | 70·1 | 0·3209 (*d*) |
| 1024 | 89·29 | 79·2 | 0·2947 (*d*) |

*Investigator.*—(*a*) N. and W., First Series; (*b*) N. and W., Second Series; (*c*) Trey; (*d*) Ley.

It will be seen from the last column that the conductivity value of Trey corresponds well with ours, but those of Ley are considerably less, especially in the dilute solutions (1/128 to 1/256 normal).

The results show clearly that lead acetate is much less ionised than is usual with unibivalent salts, which are commonly 70 to 75 per cent ionised in 0·1 normal solution. The results of Ley with other acetates of this type show too that even these have a much higher conductivity than lead acetate; thus, for 1/32-normal solutions he obtained the following equivalent conductivities in reciprocal ohms:—Barium acetate, 80·0; manganese acetate, 66·6; nickel acetate, 64·6; cobalt acetate, 65·9; zinc acetate, 62·3; and cadmium acetate, 54·5; while that of lead acetate is only 37·6.

The actual values of the conductivity-ratio given in the table are not to be regarded, however, as a true measure of the ionisation, for it is very probable in view of its slight degree of ionisation that this salt forms the intermediate ion PbAc+ in large quantity.

Moreover, since the $\Lambda_0$ value for dissociation into the two ions PbAc+ and Ac− would be very different from that for dissociation into the three ions Pb++ and 2Ac−, which last was assumed in computing the ratio, it is not proved by the constancy (in the stronger solution) of the function given in the last column that the former kind of ionisation alone takes place, but only that the latter kind is not the exclusive one.

## IV. *Migration Experiments.*

Two series of qualitative migration experiments were made. In one of these, the solutions, in order to avoid stirring, were gelatinised by the addition of agar; in the other, to eliminate the possibility of any influence of the agar upon the lead salt, difference in specific gravity was alone relied upon.

In the former series a U-tube 1·75 c.m. in diameter and 15 c.m. in height was used. The bend was filled with an agar jelly made up with a normal ammonium acetate solution, and containing zinc sulphide in suspension. Above this in each arm of the tube were placed, first, a plug of jelly 0·5 c.m. long with ammonium acetate solution alone; next, one also saturated with lead sulphate; then, another one 0·5 c.m. long with ammonium acetate alone; then, one with this salt in solution and zinc sulphide in suspen-

sion; and finally, some ammonium acetate solution without agar, in which platinum-wire electrodes were placed. The tube was immersed in a bath of ice-water. The electrodes were kept at a potential difference of 80 volts for two hours, but at no point did the zinc sulphide become blackened, showing that the lead did not migrate to an appreciable extent in either direction.

Of the experiments made with solutions without agar added, only the final and most conclusive one need be described. The apparatus used consisted essentially of two U-tubes connected by side-arms, one of the tubes being joined at the bottom of the bend to a glass tube of small bore. The tubes were completely filled with half-normal ammonium acetate solution; then both arms of one of them were tightly stoppered, and by means of suction applied to both arms of the other, a normal solution of ammonium acetate saturated with lead sulphate, and strongly coloured with rosaniline hydrochloride, was slowly drawn up through the small glass tube at the bottom until the bend was sealed. The solutions had been brought to a constant temperature of 25° previous to the filling, which took place immediately over the thermostat. A difference of potential of 110 volts was applied, and the current (of 0·2 ampère) was passed for two hours. The length of the column of solution was 73 c.m., thus giving a drop in potential of 1·5 volts per c.m. The colour boundary remained sharp, and nearly stationary, showing there was no stirring. At the end of the experiment, successive portions were carefully withdrawn by means of a pipette from both arms of the tube containing the dissolved lead sulphate, almost down to the colour boundary. To each of these portions was added potassium chromate, which furnishes a very delicate test for lead even in acetate solution. None of the portions from the cathode side gave any indication of lead, even down to the line of separation. In the portions on the anode side there was a trifling quantity of lead in the portion immediately adjoining the lead sulphate solution, but a portion 2·4 c.m. away gave no precipitate whatever with the potassium chromate. An ordinary lead ion, for example, in a 0·2 normal lead nitrate solution, moves under a potential gradient of 1 volt per c.m. about 0·00040 c.m. per second, so that under the conditions of our experiment, it would have moved about $0{\cdot}00040 \times 1{\cdot}5 \times 7200 = 4{\cdot}3$ c.m., while, in fact, no considerable quantity of the lead migrated more than a small fraction of a c.m. On the other hand, the $SO_4$ ions migrated several c.m. in the same time, for a precipitate of barium sulphate was obtained in all the portions from the anode arm upon the addition of barium chloride and acidifying with hydrochloric acid, while the solution in the cathode arm gave no such indication of the presence of sulphate.

Both of these series of experiments lead to the same conclusion, namely, that substantially all the lead exists in the acetate solution in the form of un-ionised compound.

### V. *Experiments on the Solubility of Lead Sulphate in Ammonium Acetate Solutions.*

Since ammonium acetate is very hygroscopic, it is impracticable to obtain a solution of known strength by weighing out the salt. The solution was therefore prepared by the neutralisation of ammonium hydroxide with acetic acid. Pure ammonia, free from amines, was prepared by the following method (Bender u. Erdmann, "Preparatenkunde," p. 234):—Commercial ammonium chloride, "free from hydrocarbons," was dissolved in enough boiling water to form a saturated solution. One-tenth of its volume of nitric acid (sp. gr. 1·42) was added, and the solution boiled until there was no further evolution of chlorine. The solution was then allowed to cool, the crystallised salt dissolved in water, one-twentieth of its volume of nitric acid added, and the solution again boiled as long as chlorine was given off. After diluting sufficiently to form a nearly saturated solution when cold, the salt was decomposed by lime. The ammonia was absorbed in conductivity water, carbon dioxide being carefully excluded by the use of soda-lime tubes. The ammonium hydroxide solution so obtained was standardised with the help of methyl orange against a solution of pure hydrochloric acid, whose strength had been determined by precipitation with silver nitrate. An acetic acid solution was prepared by diluting glacial acetic acid with water. It was standardised with the help of phenolphthalein against the barium hydroxide solution, which had been titrated against the hydrochloric acid. The standardisations were made by weight, so as to give the number of grms. of acetic acid solution which were equivalent to 1 grm. of ammonium hydroxide solution. The neutral ammonium acetate solution was then prepared by adding to a given weight of the latter solution the appropriate weight of the former. Taking into account also the specific gravity of the two solutions, the concentration of the ammonium acetate solution so obtained was calculated to be 0·4141 equivalent per litre. The lead sulphate used was prepared by precipitating the commercial chemically pure lead acetate from solution by sulphuric acid, dissolving the precipitate in pure ammonium acetate, and re-precipitating with sulphuric acid.

For the determination of the lead dissolved in the ammonium acetate solution, two methods were tested by using known weights of pure lead sulphate. The first consisted in precipitation as lead chromate from acetic acid solution, filtering upon a Gooch crucible, and drying at 170°; the second in precipitation as lead sulphate by sulphuric acid, filtering upon a Gooch crucible, washing first with dilute sulphuric acid, and then with 50 per cent alcohol, and drying at 170°.

The former method gave results about 0·7 per cent too high, owing probably to the carrying-down of an excess of chromic acid; the latter method gave results which trial analyses showed to be accurate within 0·05 per cent.

The solutions were saturated by rotating the ammonium acetate solutions with a large excess of solid lead sulphate for fifteen hours within a thermostat at 25° in the manner previously described (Noyes, *Zeit. Phys. Chem.*, 1892, ix., 606). In half the determinations (marked *s* in the table below) the equilibrium was approached from the supersaturated side, by cooling a solution which had been shaken with the salt at a higer temperature, while in the other half (marked *u* in the table) it was approached from the undersaturated side, by heating the solution from the room temperature to 25°. It will be seen that the two procedures gave substantially identical results.

Table III. contains the results obtained, the solubility of the lead sulphate as well as the concentration of the ammonium acetate being expressed in the first three columns in millimols. per litre. In the fourth column the solubility in grms. per litre is added. For comparison, is included also the solubility in pure water, or rather the concentration of the ionised portion in the saturated solution in water, as determined by Böttger by conductivity measurements (*Zeit. Phys. Chem.*, 1903, xlvi., 604).

Table III.—*Solubility of Lead Sulphate in Ammonium Acetate Solutions at 25°.*

| Concentration of $NH_4C_2H_3O_2$. | Solubility of $PbSO_4$. Separate determination. | Mean millimols. per litre. | Mean grms. per litre. |
|---|---|---|---|
| 0·0 | — | 0·134 | 0·041 |
| 103·5 | 2·10 *s* | 2·10 | 0·636 |
| — | 2·10 *u* | | |
| 207·1 | 4·54 *s* | 4·55 | 1·38 |
| — | 4·56 *u* | | |
| 414·1 | 10·12 *s* | 10·10 | 3·06 |
| — | 10·09 *u* | | |

It is seen from the table that the solubility is about fifteen times as great in 0·1 normal ammonium acetate solution as in water, and that it increases with increasing concentration of the salt somewhat, but not very much, more rapidly than proportionality between solubility and concentration would require.

It seems certain from the conductivity and migration experiments above described that this increase of the solubility is mainly due to the formation of un-ionised lead acetate, accompanied, of course, by the production of an equivalent quantity of ammonium sulphate, which would exist partly as ions and partly as un-ionised molecules. Assuming now that the solubility product, $C_{Pb} \times C_{SO_4}$, retains the same value as in pure water, the solubility in any ammonium acetate solution might be computed if it were possible to determine the resulting concentration of un-ionised lead acetate—a quantity which is substantially equivalent to that solubility. Unfortunately, however, our knowledge of the ionisation-relations, not only of lead acetate itself, but also in general of mixtures of salts which do not conform to the mass action law, is still very imperfect, and any assumption that may be made, especially with regard to the slightly ionised lead acetate, is arbitrary. Nevertheless, it is perhaps not without interest to determine whether the solubility-change with the concentration is satisfactorily explained if it be assumed that this salt follows the mass action law (which may well be true in virtue of its small ionisation tendency), and that ammonium sulphate follows the empirical law which has been shown to apply to mixtures of largely ionised salts (see Noyes, *Science*, 1904, xx., 577; *Tech. Quart.*, 1904, xvii., 293; *Journ. Am. Chem. Soc.*, xxvii., R, 203). We then have the the equilibrium equations:—

$$C_{Pb} \times C_{SO_4} = S_0^2, \quad C_{Pb} \times C^2_{Ac} = K_1 C_{PbAc_2},$$
$$\text{and } C_{Am} \times C_{SO_4} = K_2 C_{Am_2SO_4} C_i^m;$$

where $S_0$ is the solubility of lead sulphate in pure water, $K_1$ and $K_2$ are equilibrium-constants, $m$ is an empirical exponent, and $C_i$ is the total concentration of all the positive or negative ions in the solution. Furthermore, if S is the solubility of lead sulphate in a solution of ammonium acetate of concentration C and ionisation $\gamma$, the following relations given by the conditions of the problem also hold true approximately:—

$$C_{PbAc_2} = S, \; C_{SO_4} + C_{Am_2SO_4} = S, \text{ and } C_{Am} = C_{Ac} = C_i = C\gamma.$$

Combining these equations, we get—

$$S = \frac{S_0}{\sqrt{K_1}} (C\gamma)\left(1 + \frac{1}{K_2}(C\gamma)^{1-m}\right)^{\frac{1}{2}}.$$

Now Kohlrausch's conductivity measurements at 18° with potassium sulphate, whose ionisation relations may be assumed identical with those of ammonium sulphate, show that $m = 0{\cdot}59$ and $K_2 = 0{\cdot}881$ when computed for the concentrations between 0·1 and 0·5 normal. The preceding equation therefore becomes—

$$S = \frac{S_0}{\sqrt{K}} C\gamma\left(1 + 1{\cdot}135\,(C\gamma)^{0{\cdot}41}\right)^{\frac{1}{2}}.$$

It will be seen at once that this equation requires that the solubility increase a little more rapidly than the ionic concentration of the salt. By means of it the solubility at the two concentrations, 0·1036 and 0·414 molal can be computed from that in the 0·207 molal solution, the value of $S_0/\sqrt{K_1}$ being first calculated from the data for the latter. For these purposes we have obtained $\gamma$ from the conductivity data of Kohlrausch at 18° for sodium acetate, whose ionisation relations doubtless correspond closely to those for ammonium acetate. We have thus calculated the solubility at the other two concentrations, and found it to be that shown in the following table. The concentrations of the ammonium acetate are here expressed in equivalents and those of the lead sulphate in millimols. per litre.

TABLE IV.—*Observed and Calculated Solubilities of Lead Sulphate.*

| Concentration of $NH_4C_2H_3O_2$. | Ionisation of $NH_4C_2H_3O_2$. | Solubility of $PbSO_4$. Observed. | Calculated. |
|---|---|---|---|
| 0·1035 | 0·775 | 2·10 | 2·34 |
| 0·2071 | 0·724 | 4·55 | — |
| 0·4141 | 0·652 | 10·10 | 8·56 |

It will be seen that the change of solubility with the concentration is roughly, and only roughly, that required by the foregoing formula.

Finally, it may be mentioned that, to determine whether the requirement of the hypothesis is fulfilled, that sodium acetate has nearly the same effect on the solubility of lead sulphate as ammonium acetate, normal solutions of these two substances were shaken occasionally at room temperature for two days with an excess of solid lead sulphate, and a 100 c.c. portion of each was analysed for its lead-content. The ammonium acetate solution yielded 0·42 grm., and the sodium acetate solution 0·45 grm. of lead sulphate. These experiments were very rough ones, for the solutions were made up by weighing out the commercial "chemically pure" salts without thorough drying, the temperature was variable, and complete saturation may not have been reached. Still they certainly show that the two salts have, at least roughly, the same effect.

### VI. *Summary.*

New measurements of the conductivity of lead acetate solutions at 25° between ½- and $\frac{1}{128}$-normal, have been presented, which show that this salt has an abnormally small degree of ionisation (only about 22 per cent at 0·1 normal, assuming that it dissociates directly into three ions).

Qualitative migration experiments made with a saturated solution of lead sulphate in normal ammonium acetate solution have been described, which show that the lead in this solution is not present to an appreciable extent in the form of either a positive or negative ion.

The solubility of lead sulphate (in millimols. per litre) has been found to be 2·1 in 0·104 normal ammonium acetate solution, 4·55 in 0·207 normal, and 10·1 in 0·414 normal. The solubility is very much greater than that in pure water (0·134 millimol. per litre according to Böttger), and is roughly proportional to the concentration of the ammonium acetate. Rough comparative experiments with sodium acetate and ammonium acetate showed that the solubility of lead sulphate in solutions of these two salts is of about the same magnitude.

These facts all indicate that the increased solubility of lead sulphate in acetate solutions arises mainly from the formation of un-ionised lead acetate by metathesis.

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## THE STUDY OF ABSORPTION SPECTRA IN RELATION TO THE CHEMICAL STRUCTURE OF COLOURLESS AND COLOURED SUBSTANCES.*

By WALTER NOEL HARTLEY, F.R.S.,
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THE hydrocarbons, unless of the benzene type, exert a continuous absorption of the ultra-violet rays, but the aromatic hydrocarbons commencing with the simplest in structure benzene exhibit spectra with absorption bands. Benzene exhibits different bands and bands differently situated, though evidently related, according to whether it is examined in the state of vapour or in solution in alcohol (Paur, *Wiedemann's Ann.*, 1891, lxii., 663; W. Friederichs, *Zeit. f. Wissenschaftliche Photographie*, 1905, iii., 154; also L. Grebe, iii., 376). When, the substance is in a state of vapour there are differences corresponding—1st, to temperature, 2nd, to pressure, as well as to the thickness of the layer of vapour examined. The spectrum is a very complex one; no fewer than 91 narrow bands have been measured in my laboratory on one photograph taken from a column of air 12 c.m. long, saturated with benzene vapour at a temperature of 25° and 759·5 m.m. barometric pressure. When the hydrocarbon is in solution, the spectrum varies with the quantity of substance which the

* A Paper read at the Sixth International Congress of Applied Chemistry, Rome, April 27th, 1906.

rays traverse, or with the concentration of the solution. Working with instruments of small dispersion, such as the usual quartz spectrograph, there are eight bands or groups of bands in the spectrum of benzene dissolved in alcohol, six of which are seen to be of special importance, and of the six there are four which are not only better defined but more persistent or of greater intensity and breadth than the others, and they appear to be similarly constituted. A similar group of four bands occurs in the spectra of solutions of naphthalene, anthracene, and phenanthrene, but situated in less refrangible rays as the molecules are more complex, one of the bands of anthracene being in the violet. The spectrographic examination of organic products was first usefully applied in the study of essential oils, these being articles of great commercial value (Hartley and Huntington, *Proc. Roy. Soc.*, 1880). The hydroaromatic hydrocarbons and the camphors show spectra with different absorptive powers but without absorption bands, and of these thirty-five were examined. But from many essential oils, substances with a different constitution were separated which had a powerful absorption, and showed spectra with bands characteristic of the aromatic group. Thirteen samples of such substances showed that by diluting the original oils with alcohol the presence of bodies of the aromatic class could be detected, and in some cases the amount of these substances was estimated. Hydrocarbons derived from benzene by substitution of alkyl radicals for hydrogen exhibit modifications of the benzene spectrum in this respect, that several small bands are merged into one broad one, but, as a rule, two or three narrow bands are observed in the less refrangible part of the spectrum. Cymene is a good example of this, and by the absence of its bands it was concluded that its natural occurrence in essential oils is rare, though judging from its absorption spectrum, as much as four per cent was found in a Russian oil of turpentine. As it is easy to distinguish between aliphatic, hydroaromatic, and aromatic hydrocarbons, between alkylamines and aromatic bases, alcohols and phenols by their absorption spectra, and particularly by what I have described as the curves of molecular vibrations, so also isomeric substances of the aromatic group have different absorption curves which are invariably the same for the same pure substance. By comparing the curve of natural salicylic acid obtained from oil of wintergreen with the artificial product made by crystallising the calcium salt, the identity of the two products was established, and the pure commercial product was found to possess the properties now described as "physiologically pure." More recently the identity in constitution of phloroglucinol was established in specimens prepared from five different sources (Hartley, Dobbie, and Lauder, *Chem. Soc. Trans.*, 1902, lxxxi., 929).

Heterocyclic compounds and derivatives such as pyridine and quinoline, behave like the homocyclic rings, inasmuch as they show powerful absorption bands.

The application of the spectrographic method to the identification of the alkaloids, and for studying their constitution, has very clearly established its value. Thus the absorption spectra of a number of pure specimens were first photographed by the author; three years afterwards the same solutions were examined and compared with another series freshly prepared, the work being entrusted to an assistant, and a comparison of the two series of measurements of the spectra made independently showed no difference between them. Thirteen years later another collection of specimens was examined by Messrs. Dobbie and Lauder, and as their measurements agreed with the previous ones, there is shown to be no difficulty in identifying pure specimens. The action of different solvents, and of acids and bases on the alkaloids, may be very usefully employed in connection with the spectrograph, always provided that the use of nitric acid be excluded, because nitric acid itself yields an absorption band in the ultra-violet, whereas acetic, hydrochloric, and sulphuric acids do not. The absorption curves of the hydrochlorides differ somewhat from those of he bases, and some of them, such as those of tertiary bases, are liable more or less to undergo hydrolysis. An important consideration in the spectrographic examination is the very small quantity of a substance required; most usually this is not more than a molecular weight in m.grms., or it may be only 0·1 gr. when the molecular weight of the substance is not known. The substance is not lost, but may be regained by evaporating the solvent after the solution has been used.

The following generalisations are of practical utility:—

If the absorption curve of a substance of which the composition and molecular weight are known, but the constitution is unknown, be compared with the curve of a similar substance the constitution of which has been ascertained, and if it be found that the difference between the curves amounts to no more than trifling differences in detail, it is right to assume that they both have the same structure.

Substances with the same formulæ giving widely different absorption curves or series of absorption spectra, are themselves structurally different.

Substances which, from their formulæ, are supposed to be homologous, are structurally different if their absorption curves differ widely.

Alkaloids which differ by $CH_2$ and are strictly homologous show curves which are practically identical.

Substances with the same molecular weight which give absorption curves which are identical, have the same structure, but if with the same structure they differ in optical properties, such as the rotation of a ray of polarised light, they are probably stereo-isomerides (Dobbie and Lauder, *Brit. Assoc. Report*, 1903).

Alkaloids which differ from one another simply by variations in the composition of side-chains, but not in that of the nucleus, show but slight alterations in their absorption curves.

*Tautomerism.*—In the study of tautomerism the absorption spectra are most valuable, because nothing but the solvent need come into contact with the substance to be examined, and the effect of different solvents may be studied, but in all such cases experience has shown that it is advisable to avoid the application of heat for the purpose of facilitating solution, and also to photograph the spectra as soon as possible after the solution has been prepared, otherwise desmotropic changes may spontaneously take place. The action of heat is capable of causing such changes rapidly, which, at ordinary temperatures, require days, or even weeks, for their completion. Cotarnine is an example of an alkaloid which Dobbie, Lauder, and Tinkler (*Chem. Soc. Trans.*, 1904, lxxxv., 121) have shown exists in two isomeric states, according to whether it is dissolved in ether or alcohol. Brühl has shown that a comparison of the physical properties of benzene—namely, its density, its refraction equivalent, its molecular volume at 20° C., its specific dispersion, molecular refraction, and molecular dispersion—with the similar properties of dihydrobenzene, tetrahydrobenzene, hexahydrobenzene, hexane, hexylene, diallyl, and dipropargyle, presents a complete substantiation of the formula by which Kekulé represented the special chemical properties of benzene as being a consequence of its constitution (*Ann. Chem. Pharm.*, clxii., 86). This conclusion has also been confirmed by its absorption spectrum and that of its derivatives. Furthermore, von Baeyer has obtained chemical evidence of the benzene nucleus existing in two different states which are to be considered as tautomeric; the difference between them being due to a different linking of the carbon atoms within the molecule, but not to any change in the position of the hydrogen atoms. It has been termed phaseotropy by Laar (*Ber.*, 1901, xxxiv., 3516). This also agrees with Kekulé's view, and is also in harmony with recent work on absorption spectra. To consider this subject in all its bearings, it is necessary to take into account the relationship of certain colourless compounds to the coloured derivatives obtained from them. The curves of molecular vibrations of benzene, triphenyl methane and the dyes derived from them, and similarly benzene, azo-benzene, and

the azo-dyes afford evidence of the physical relationship of the colourless to the coloured compounds (*Chem. Soc. Trans.*, 1887, li., 153).

Murexide was the only purely organic colouring matter of approximately ascertained constitution at that time which was not derived from benzene. To account for the absorption band in uric acid, and the colour developed in murexide, it was stated that it apparently depended upon a peculiar linking of the CO and N groups in these compounds. Since 1887 we have become acquainted with several others, such as the unsaturated ketones (O. Wallach, *Chem. Central.*, 1897, i., 373), ethylnitrolic acid, and violuric acid which yield coloured salts and coloured solutions. The chromogenic properties of these acid-forming substances have been accounted for by the simultaneous operation of a physico-chemical change and a purely chemical one, both of which are included in the term ionisation isomerism (A. Hantzsch, *Ber.*, 1899, xxxii., 575, also 307; J. Guinchard, *Ber.*, 1899, xxxii., 1723). Messrs. Bier and Marchlewski have drawn attention to the fact that atomic groupings are apparently the cause of a band or bands in the absorption spectra of certain compounds and not the nucleus of the compound simply, as in benzene and triphenylmethane and its derivatives (Extrait du *Bull. Acad. des Sciences de Cracovie*, April, 1902), and in this connection a spectrographic and chemical examination of uric acid, the ureides, and murexide has placed us in possession of the following facts (*Chem. Soc. Trans.* 1905, lxxxvii., 1791—1831).

Urea and the ureides, alloxan, barbituric acid, dialuric acid, alloxanic acid, potassium alloxanate, pure violuric acid, uramil, and guanine hydrochloride show no absorption band or bands in their spectra, and as a rule they transmit the ultra-violet rays very freely. These oximino-rings have the same optical properties as cyanuric acid and its esters, tricarbamide and its esters, melamine and its triethyl esters, also diketohexamethylene (*Brit. Assoc. Report*, 1901, Hartley, Dobbie, and Lauder). Substances which show bands in their absorption spectra, or in which bands may be developed by a tautomeric change are—(*a*) certain oxypurin derivatives, and (*b*) diureides, or substances which contain two oximino-rings linked together by oxygen or by nitrogen. The substances referred to are uric acid and alkali urates, alkali violurates, caffeine, theobromine, ethoxy-caffeine, and alloxantin. In order to determine whether any particular structural differences occur in the constitution of those substances which exhibit absorption bands and those which do not, their properties were carefully examined and compared.

First, a ring structure is not essential, since simple oximino-ketone rings show no bands.

Secondly, the oxypurin compounds which show bands in their spectra are easily converted into simple oximino-ketones which do not.

Thirdly, the unsaturated ketones, some of which are open chain compounds, have ethylenic linkings associated with a carbonyl group (C:O), which arrangement is apparently the cause of their colour.

Fourthly, by methylating oxycaffeine, E. Fischer obtained the ketonic and enolic isomerides, tetra-methyluric acid, and methoxycaffeine. W. Wislicenus and Körber found (*Ber.*, 1902, xxxv., 1992), by continued heating, ethoxycaffeine is converted into trimethyluric acid. These changes reduced to their simplest expression may be represented thus:—

$$\begin{array}{c} -C{:}O \\ | \\ -N\ \text{Alkyl} \end{array} \rightleftarrows \begin{array}{c} -C{\cdot}O\ \text{Alkyl} \\ \| \\ -N \end{array},$$

where the conversion of the ketonic into the enolic form causes a doublel inking (C:O) external to the ring, to be changed to a double linking within the ring. Spectrographic observations have also revealed the fact that these tautomeric changes do take place in some of the oxypurin derivatives, and that they are liable to occur in all, and are accelerated by heat.

Guanine hydrochloride which shows no band, contains three double linkings in a ring structure, but the other five purin compounds contain but two; it is obviously not the three ethylenic linkings which cause the band, but the number and disposition of the ketone complexes, with respect to double linking, which admits of the change $\begin{array}{l} :N \\ \cdot NH \end{array}\!\!>CO \rightarrow \begin{array}{l} :N \\ \cdot N \end{array}\!\!\geqq C{\cdot}OH$ in the 2:6:8- and 2:6-oxypurins, with the simultaneous double linking within the ring when the ketonic passes into the enolic form. The diureide alloxantin in aqueous solution shows a band which afterwards disappears by reason of the substance being hydrolysed into dialuric acid and alloxan.

Fifthly, it may be pointed out that the alkali and alkaline earth metals induce the formation of a band in certain compounds, and intensify it where it is already existent; they also produce colour.

A similar action is to be attributed to aluminium hydroxide in its effect on acetylacetone and ethylacetoacetate. Baly and Desch attribute the formation of a band in the spectrum of acetylacetone not solely to one structure, or another which it is possible to formulate for the same substance, but to the change from the one to the other structure (*Chem. Soc. Trans.*, 1904, lxxxv., 1029). Now colour has been cited by T. M. Lowry as evidence of isodynamic change, since nearly all coloured substances can be repre- by two formulæ (*Brit. Assoc. Report*, Cambridge, 1904, pp. 193—224). The terms *dynamic isomerism* and *tautomerism*, though applied to the same class of phenomena, are not identical in meaning. *Dynamic isomerism* implies a state of equilibrium between two or more isomeric forms in different molecules of the same compound. By *tautomerism* it must be understood that, the oscillation of a hydrogen atom between two positions in the one molecule endows the molecule with a different structure at each phase of the vibration, so that it possesses the properties alternately of two isomeric forms. This is strictly a reversible isomerism. Equilibrium between isomers in many cases is possible only in presence of a third substance, which may be a minute trace of impurity. Equilibrium may be affected by the solvent, concentration, and temperature. By assembling and collating the foregoing facts and theories we arrived at the following generalisation:—

*In benzenoid hydrocarbons, oximino-, or ketonic compounds, the occurrence of a banded spectrum results from either phaseotropy, isodynamic change, or tautomeric change; and for the isodynamic or tautomeric change to become possible, a certain peculiarity in structure is necessary.*

(To be continued).

## ELECTRO-CHEMICAL CALCULATIONS.*

By JOSEPH W. RICHARDS.

(Concluded from p. 21).

### POTENTIAL FOR MIXED ELECTROLYSIS.

THE above data are easily applied when the current is doing only one thing, *i.e.*, is separating out or dissolving only one element. But in many cases the current is causing a compound anode to dissolve, as when copper and silver both dissolve from a silver bullion anode; or two or more metals may be simultaneously deposited, as when copper and zinc are deposited together as brass. In all such cases, the simplest procedure is to foot up the thermochemical energy of the total electro-chemical change for any given time or number of coloumbs passing. Then express this per 96,540 coulombs passing, and divide by 23,040; the quotient will be $V^d$.

$$\text{Voltage drop } (V^d) = \frac{Q \text{ for } 96{,}540 \text{ coulombs passing}}{23{,}040}.$$

* From the *Journal Franklin Institute*, February and March, 1906.

*Example.*—An electrolyte contains zinc sulphate with some copper sulphate, and is electrolysed with a copper anode. There is deposited upon the cathode in one hour 15 grms. of brass, containing one-third zinc and two-thirds copper. What voltage drop will occur in the cell in addition to that necessary to overcome its ohmic resistance?

*Solution.*—The coulombs passing are those necessary to deposit 5 grms. of zinc (chemical equivalent, 65÷2) and 10 grms. of copper (chemical equivalent 63·6÷2).

$$\text{Coulombs for zinc} = \frac{5\cdot0000}{0\cdot00001035 \times (65 \div 2)} = 14{,}864$$

$$\text{Coulombs for copper} = \frac{10\cdot0000}{0\cdot00001035 \times (63\cdot6 \div 2)} = 30{,}383$$

$$\text{Sum} = 45{,}247$$

The weight of copper dissolved will be, on the same principles,—

$$45{,}247 \times 0\cdot00001035 \times (63\cdot6 \div 2) = 14\cdot892 \text{ grms.}$$

The solution of 14·892 grms. of copper and deposition of 10 grms. of the same element, shows that the only thermo-chemical energy required is that absorbed for the solution of 4·892 grms. of copper, and deposition therefore of 5·0 grms. of zinc. The thermo-chemical equation is—

$$ZnSO_4aq + Cu = CuSO_4aq + Zn$$
$$-248{,}000 \qquad +197{,}500 \qquad = -50{,}500 \text{ calories.}$$

Showing that 50,500 calories is absorbed for every 65 grms. of zinc (its atomic weight) thus deposited. This equals an absorption of 3885 calories per 5 grms. of zinc, or for the whole period, during which 45,247 coulombs passed through the cell. For every 96,540 coulombs passing, the thermo-chemical heat absorption is—

$$\frac{3{,}885}{45{,}247 + 96{,}450} = 8289 \text{ calories,}$$

and the voltage drop is—

$$V^d = \frac{8{,}289}{23{,}040} = 0\cdot36 \text{ volt.}$$

The above calculation is on the assumption that the copper and zinc deposit separately, as mixed crystals. If they really deposit as a chemical combination, the heat of formation of the alloy would need to be considered also in the above calculation.

The main point sought to be emphasised by the foregoing statements and illustration is that the current may, and very often does, do two kinds of chemical work simultaneously, requiring, if each alone took place separately, different drops of potential to accomplish the chemical work; in such cases, the only safe ground is to say that the coulombs passing must furnish the sum total of all the energy for all the chemical changes induced at the electrode surface, and therefore must drop sufficiently in potential to furnish the energy required (in addition, of course, to the ordinary drop of potential caused by the ohmic resistance of the bath).

### Current for Mixed Electrolysis.

When the current is dissolving or depositing only one element, the calculation of the quantity of material concerned with a given transfer of electricity is a simple question:—The Faraday, 96,540 coulombs, dissolves or deposits one chemical equivalent weight in grms.

If, however, two or more elements are simultaneously dissolved or deposited, as occurs frequently in metal refining or plating, the calculation is not so simple. The proper procedure in that case is to find how many coulombs are required for the separate weights of each element dissolved or deposited, and add these together to obtain the total current needed. Or, if the current used is given, and the question is the amounts of mixed metals dissolved or deposited, obtain the coulombs necessary to dissolve or deposit 1 kilogrm. of the alloy or mixed metals, and divide this into the total coulombs used.

*Example.*—In the Wohlwill process of refining gold bullion, the anodes consist of 80 per cent gold, 8 per cent silver, 10 per cent copper, and 2 per cent platinum. One hundred and fifty ampères pass through each cell, attacking or corroding the anodes uniformly, while the silver deposits at the bottom of the bath as AgCl, gold is deposited pure on the cathodes, and platinum and copper accumulate in the solution as $PtCl_4$ and $CuCl_2$ respectively.

*Required.*—1. How much weight of anode is corroded per twenty-four hours?

2. How much more gold is deposited than is dissolved?

3. What voltage of decomposition, to represent chemical work, must be furnished?

*Solution.*—1. One kilogrm. of anode contains—

| | |
|---|---|
| Gold .. .. .. .. .. | 800 grms. |
| Silver .. .. .. .. .. | 80 „ |
| Copper .. .. .. .. .. | 100 „ |
| Platinum .. .. .. .. | 20 „ |

The coulombs necessary to dissolve these weights and to convert these metals into $AuCl_3$, AgCl, $CuCl_2$, and $PlCl_4$ are:—

| | | Coulombs. |
|---|---|---|
| Gold .. | 800÷(0·00001035×197 ÷3) = | 1,177,076 |
| Silver .. | 80÷(0·00001035×108 ÷1) = | 71,570 |
| Copper .. | 100÷(0·00001035× 63·6÷2) = | 303,831 |
| Platinum.. | 20÷(0·00001035×195 ÷4) = | 39,638 |
| | | 1,592,115 |

Coulombs available per twenty-four hours—

$$150 \times 60 \times 60 \times 24 = 12{,}970{,}000.$$

Anode corroded away in twenty-four hours, per cell—

$$12{,}970{,}000 \div 1{,}592{,}115 = 8\cdot146 \text{ kilogrms.}$$
$$= 8{,}146 \text{ grms.} \qquad (1)$$

2. The weight of gold deposited, by the total current, is

$$12{,}970{,}000 \times (0\cdot00001035 \times 197 \div 3) = 8815 \text{ grms.}$$
$$\text{Amount dissolved, } 8146 \times 0\cdot80 = 6717 \text{ „}$$

$$\text{Shortage in each cell, per 24 hours} = 2098 \text{ „} \qquad (2)$$

This shortage, it will be recalled, has to be made up by dissolving some of the bullion in acid, and adding to the cells. There would be required 2098÷0·80 = 2747 grms. of bullion thus dissolved, making the total bullion treated per cell per day 8146+2747 = 10,893 grms., of which 8146 grms. or 74·8 per cent would be treated electrolytically in the cell, and the rest, 25·2 per cent, would be dissolved chemically, and yet when added to the electrolyte, its gold deposited electrically.

3. Basing calculations on the solution of a kilogrm. of anode, requiring the passage of 1,592,115 coulombs (16·49 Faradays), the 800 grms. of gold dissolved has a corresponding 800 grms. deposited, so that no chemical energy needs to be expended for it. For the other elements we have the following equations and heat absorptions or evolutions:—

$$AuCl_3,aq + 3Ag = Au + 3AgCl$$
$$-27{,}200 \qquad +3(29{,}000) = +59{,}800 \text{ calories.}$$
$$2AuCl_3,aq + 3Cu = 2Au + 3CuCl_2aq.$$
$$-2(27{,}000) \qquad +3(62{,}500) = +133{,}500 \text{ „}$$
$$4AuCl_3,aq + 3Pt = 4Au + 3PtCl_4aq.$$
$$-4(27{,}000) \qquad +3(79{,}800) = +131{,}400 \text{ „}$$

The above heat evolutions are for the solution of, respectively,—

| | | |
|---|---|---|
| 3 grms. atomic weights of silver | = 324 | grms. |
| 3 „ „ „ copper | = 190·8 | „ |
| 3 „ „ „ platinum | = 585·0 | „ |

The heat evolution per kilogrm. of anode corroded will therefore be for:—

| | | | | |
|---|---|---|---|---|
| 80 grains silver | = | $\frac{80}{324} \times 59{,}800 = 14{,}765$ | calories |
| 100 „ copper | = | $\frac{100}{190{\cdot}8} \times 133{,}500 = 69{,}980$ | „ |
| 20 „ platinum | = | $\frac{20}{585} \times 131{,}400 = 450$ | „ |
| | | Sum = 85,195 | „ |

This heat evolution takes place for the passage of 1,592,115 coulombs (16·46 Faradays). For one Faraday (96,540 coulombs) it will be,—

$$85{,}195 \div 16{\cdot}49 = 5167 \text{ calories,}$$

and since one Faraday falling in potential one volt represents 23,040 calories, the heat *evolution* will *generate*—

$$5167 \div 23{,}040 = 0{\cdot}224 \text{ volts,}$$

which means that the fall of potential for chemical work is negative, *i.e.*,

$$V^d = -0{\cdot}224 \text{ volts} \quad . \quad . \quad . \quad . \quad (3)$$

It is interesting to note that, the observed total drop of potential across the baths being 0·7 volt, the voltage drop to overcome ohmic resistance must be *greater* than this, *i.e.*,

$$V = V^d + V^c$$
$$0{\cdot}7 = -0{\cdot}224 + V^c$$
$$V^c = 0{\cdot}7 + 0{\cdot}224 = 0{\cdot}924 \text{ volt,}$$

making the ohmic resistance of the cell—

$$R = \frac{0{\cdot}924}{150} = 0{\cdot}00616 \text{ ohms}$$
$$= 6{\cdot}16 \text{ milli-ohms.}$$

Further, if no external source of current were used, the cell would have available 0·224 volt electromotive force, which should, if short circuited, send—

$$\frac{0{\cdot}224}{0{\cdot}00616} = 36{\cdot}3 \text{ ampères}$$

through the bath; that is, run it at 24 per cent of the present rate, without any external generator of current.

### RISE IN TEMPERATURE OF BATHS.

A subject of much importance is that of the temperature of an electrolytic cell being maintained above the room temperature by the heating effect of the current. It is difficult to calculate ahead, before the apparatus is constructed, how high its temperature will rise above its surroundings, but it may be determined with considerable approach to accuracy how high it will be heated as soon as it has been constructed, and before electric current is applied, by a simple test.

The tank is filled with electrolyte, the electrodes put in place, and note made of the weight of electrodes and electrolyte. The tank is heated by a steam-pipe until at desired temperature above the room, and then allowed to cool by radiation, with thermometer immersed in the electrolyte so as to determine the rate of fall of temperature per minute. An ordinary tank will cool approximately twice as fast if uncovered as if covered. Tests on a small tank showed, for example, the following results :—

| | | | |
|---|---|---|---|
| At 90° C. | falling | 3·2° | per minute. |
| „ 80° | „ | 1·7° | „ |
| „ 70° | „ | 1·1° | „ |
| „ 60° | „ | 1·0° | „ |

Knowing the weight and heat capacity of the electrodes and electrolyte (to which may be added half the heat value of the tank), it can be calculated how much heat is being lost per minute at any of the above temperatures. To maintain the bath at that temperature would therefore require just that much heat to be generated within it electrically in overcoming the ohmic resistance, and if we know or have calculated the electric resistance of the bath we have,—

Heat generated in bath = (current used)$_2$ × resistance × 0·2385 calories per second,

and therefore the current required to supply any required quantity of grm.-calories per minute will be,—

$$\text{Current} = \sqrt{\frac{\text{Heat to be generated in bath per minute}}{\text{Resistance of bath in ohms} \times 0{\cdot}2385 \times 60}}$$

This same method of investigation can be applied to apparatus working with fused salts, or electric furnaces, providing that means of measuring the temperature satisfactorily are at hand.

### ENERGY REQUIRED FOR CHEMICAL WORK.

This energy must be equal in amount to the chemical work done, and the only measure of this that we have are the thermo-chemical heats of combination of the separated-out products to reform the original material. A most striking generalisation has been arrived at by the discussion of thermo-chemical data, viz., that taking the heats of formation of salts plus their heat of solution in excess of water (usually called "heat of formation to dilute solution"), these quantities are found to be *additive* in their nature, such being composed of the sum of two quantities, one characteristic once for all of the base, in all its combinations, and the other being characteristic once for all of the acid radical, in all of its combinations. There is thus for each basic element a *thermo-chemical constant*, which represents the amount of heat it contributes to the formation-heat of a salt, the latter taken in dilute solution; and for each acid radical a similar *thermo-chemical constant*, representing in a similar manner the part which it contributes; the sum of these two

TABLE I.—*Thermo-chemical Constants of Basic Elements.*

| | Per chemical equivalent. Calories. | Corresponding voltage. |
|---|---|---|
| Li· .. .. | +62,900 | +2·73 |
| Rb· .. .. | 62,000 | 2·69 |
| K· .. .. | 61,900 | 2·69 |
| Ba·· .. .. | 59,950 | 2·60 |
| Sr·· .. .. | 58,700 | 2·55 |
| Na· .. .. | 57,200 | 2·48 |
| Ca·· .. .. | 54,400 | 2·36 |
| Mg·· .. .. | 54,300 | 2·36 |
| Al··· .. .. | 40,100 | 1·74 |
| $(N+H_4)$· .. | 33,400 | 1·45 |
| Mn·· .. .. | 24,900 | 1·08 |
| Zn·· .. .. | 17,200 | 0·75 |
| Fe·· .. .. | 10,900 | 0·47 |
| Cd·· .. .. | 9,000 | 0·39 |
| Co·· .. .. | 8,200 | 0·36 |
| Ni·· .. .. | 7,700 | 0·33 |
| Fe··· .. .. | 3,230 | 0·14 |
| Sn·· .. .. | 1,900 | 0·08 |
| Pb·· .. .. | 400 | 0·02 |
| H· .. .. | 0 | 0 |
| Tl·· .. .. | −900 | −0·04 |
| Cu·· .. .. | −7,900 | −0·34 |
| Hg·· .. .. | −14,250 | −0·62 |
| Pt···· .. .. | −19.450 | −0·84 |
| Ag· .. . | −25,200 | −1·10 |
| Au··· . .. | −30,300 | −1·32 |

TABLE II.—*Thermo-chemical Constants of Acid Elements.*

| | Per chemical equivalent. | Corresponding voltage. | Salt. |
|---|---|---|---|
| $F_2''$ (gas) .. .. | +52,900 | +2·30 | Fluoride |
| $Cl_2''$ (gas) .. .. | 39,400 | 1·71 | Chloride |
| $Br_2''$ (gas) .. .. | 32,300 | 1·40 | Bromide |
| Br′ (liquid) .. .. | 28,600 | 1·20 | Bromide |
| Br′ (solid) .. .. | 27,300 | 1·18 | Bromide |
| $I_2''$ (gas) .. .. | 20,000 | 0·87 | Iodide |
| I′ (liquid) .. .. | 14,600 | 0·63 | Iodide |
| I′ (solid) .. .. | 13,200 | 0·57 | Iodide |
| S″ (solid) .. .. | −5,100 | −0·22 | Sulphide |
| Se″ (met.) .. .. | −17,900 | −0·78 | Selenide |

TABLE III.—*Thermo-chemical Constants of Acid Radicals. (From their Elements).*

| Constituents. | Radical. | Per chemical equivalent. | Correspouding voltage. | Salts. |
|---|---|---|---|---|
| $O_2$(gas),$H_2$(gas) | $(OH)'$ | +55,200 | +2·40 | Hydrate |
| S(solid),$H_2$(gas) | $(SH)'$ | 3,400 | 0·15 | Sulphydrate |
| Se(met.),$H_2$(gas) | $(SeH)'$ | 19,100 | 0·83 | Selenhydrate |
| $Cl_2$(gas),$O_2$(gas) | $(ClO)'$ | 27,500 | 1·19 | Hypochlorite |
| $Cl_2$(gas),$O_2$(gas) | $(ClO_3)'$ | 21,900 | 0·95 | Chlorate |
| $Cl_2$(gas),$O_2$(gas) | $(ClO_4)'$ | 39,400 | 1·71 | Perchlorate |
| $Br_2$(gas)$O_2$(gas) | $(BrO)'$ | 28,600 | 1·24 | Hypobromite |
| $Br_2$(gas)$O_2$(gas) | $(BrO_3)'$ | 12,500 | 0·54 | Bromate |
| I(gas)$O_2$(gas) | $(IO_3)'$ | 65,000 | 2·82 | Iodate |
| I(gas)$O_2$(gas) | $(IO_4)'$ | 52,600 | 2·28 | Periodate |
| S(solid)$O_2$(gas) | $(S_2O_3)''$ | 71,750 | 3·11 | Hyposulphite |
| S(solid)$O_2$(gas) | $(SO_3)''$ | 75,100 | 3·26 | Sulphite |
| $H_2$(gas)S(solid)$O_2$(gas) | $(HSO_3)'$ | 149,400 | 6·48 | Bisulphite |
| S(solid)$O_2$(gas) | $(S_2O_5)''$ | 115,200 | 5·00 | Pyrosulphite |
| S(solid)$O_2$(gas) | $(SO_4)''$ | 107,000 | 4·64 | Sulphate |
| $H_2$(gas)S(solid)$O_2$(gas) | $(HSO_4)'$ | 211,100 | 9·16 | Bisulphate |
| S(solid)$O_2$(gas) | $(S_2O_8)''$ | 158,100 | 6·86 | Persulphate |
| S(solid)$O_2$(gas) | $(S_2O_6)''$ | 138,500 | 6·01 | Dithionate |
| S(solid)$O_2$(gas) | $(S_3O_6)''$ | 136,500 | 5·92 | Trithionate |
| S(solid)$O_2$(gas) | $(S_4O_6)''$ | 130,600 | 5·67 | Tetrathionate |
| S(solid)$O_2$(gas) | $(S_5O_6)''$ | 133,100 | 5·78 | Pentathionate |
| Se(solid)$O_2$(gas) | $(SeO_3)''$ | 60,050 | 2·61 | Selenite |
| Se(solid)$O_2$(gas) | $(SeO_4)''$ | 72,800 | 3·16 | Selenate |
| P(solid)$O_2$(gas) | $(PO_4)'''$ | 99,300 | 4·31 | Phosphate |
| $H_2$(gas)P(solid)$O_2$(gas) | $(HPO_4)''$ | 152,750 | 6·63 | Mono-H-phosphate |
| $H_2$(gas)P(solid)$O_2$(gas) | $(H_2PO_4)'$ | 307,700 | 13·35 | Di-H-phosphate |
| As(solid)$O_2$(gas) | $(AsO_2)''$ | 102,150 | 4·43 | Arsenite |
| As(solid)$O_2$(gas) | $(AsO_4)'''$ | 70,200 | 3·05 | Arsenate |
| $H_2$(gas)As(solid)$O_2$(gas) | $(HAsO_4)''$ | 71,700 | 3·11 | Mono-H-arsenate |
| $H_2$(gas)As(solid)$O_2$(gas) | $(H_2AsO_4)'$ | 217,200 | 9·43 | Di-H-arsenate |
| $N_2$(gas)$O_2$(gas) | $(NO_3)'$ | 48,800 | 2·12 | Nitrate |
| $N_2$(gas)$O_2$(gas) | $(NO_2)'$ | 27,000 | 1·17 | Nitrite |
| $N_2$(gas)$O_2$(gas) | $(NO)'$ | −3,800 | −0·16 | Hyponitrite |
| C(amor.)$O_2$(gas) | $(C_2O_4)''$ | 99,800 | 4·33 | Oxalate |
| C(amor.)$O_2$(gas) | $(CO_3)''$ | 82,450 | 3·58 | Carbonate |
| $H_2$(gas)C(amor.)$O_2$(gas) | $(HCO_3)'$ | 169,100 | 7·34 | Bicarbonate |
| $H_2$(gas)C(amor.)$O_2$(gas) | $(CHO_2)''$ | 104,600 | 4·54 | Formate |
| $H_2$(gas)C(amor.)$O_2$(gas) | $(C_2H_3O_2)''$ | 120,500 | 5·23 | Acetate |
| $N_2$(gas)C(amor.)$O_2$(gas) | $(CNO)'$ | 37,100 | 1·61 | Cyanate |
| C(amor.)$N_2$(gas) | $(CN)'$ | −34,900 | −1·51 | Cyanide |
| S(solid)C(amor.)$N_2$(gas) | $(CNS)'$ | −18,100 | −0·79 | Sulphocyanide |
| Fe(solid)C(amor.)$N_2$(gas) | $(FeC_6N_6)''''$ | −25,600 | −1·11 | Ferrocyanide |
| Fe(solid)C(amor.)$N_2$(gas) | $(FeC_6N_6)'''$ | −52,800 | −2·29 | Ferricyanide |

thermo-chemical constants is the formation heat of the salt, from its elements, to dilute solution. The thermo-chemical constant is nothing more nor less, in the case of a base, than *energy drop* which represents the decrease of free energy in the element as it passes from the free, uncombined state into the combined state in dilute solution; in the case of an acid element, the statement is entirely similar; in the case of an acid (or basic) radical, it is the total energy drop from free elements to the state of combination as a radical.

The arbitrary basis selected to which to refer these thermo-chemical constants is best that of hydrogen constant equal to zero. This would make the thermo-chemical constant of every basic element the heat evolved when it displaces hydrogen from a dilute solution of acid; and that of an acid element or radical the heat of formation of the corresponding acid in dilute solution. Practically, the thermo-chemical constants have been evaluated by the comparison of the heats of formation of many acids and salts, and the selection of the most probable experimental values. Tables I., II., and III. have been thus derived by the writer from an extensive discussion of the subject-matter. The constants are given in every case *per one chemical equivalent* for the base or acid, element or radical, and *not* for the normal number of equivalents which are designated by the symbol and dots (·) or accents (').

I have also given the voltage drop corresponding to an energy drop of the designated number of calories per chemical equivalent, by the simple procedure of dividing the latter by 23,040.

In using these tables, it must be borne in mind that the sum of the thermo-chemical constants for the basic and acid constituents of any salt, gives the heat of formation of the salt from the constituent chemical *elements*, in dilute solution. Conversely, the heat of formation thus obtained is the energy necessary to separate the salt in dilute solution into its constituent chemical elements. The sum of the voltages, corresponding to this amount of chemical energy, is the voltage necessary to decompose the salt in solution into its constituent, free chemical elements. If these elements re-combine in the process of decomposition, to form other chemical compounds, then the whole chemical reaction must be taken into account—best on the total energy basis; and when this is expressed in calories per chemical equivalent concerned, the necessary voltage for producing the change is obtained by dividing this by 23,040.

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**Jubilee of the Coal-tar Colour Industry.**—A meeting will be held in the Theatre of the Royal Institution, Albemarle Street, Piccadilly, on Thursday, July 26, at 11 a.m. All chemists are invited.

# PROCEEDINGS OF SOCIETIES.

## FARADAY SOCIETY.

*Ordinary Meeting, July 2nd, 1906.*

Prof. SILVANUS P. THOMPSON, D.Sc., F.R.S., in the Chair.

PROF. KR. BIRKELAND, of the University of Christiania, read a paper on "*The Oxidation of Atmospheric Nitrogen in Electric Arcs.*"

The paper deals principally with recent developments of the Birkeland-Eyde process for the fixation of atmospheric nitrogen as carried out in the nitrate manufactory at Notodden and at the experimental works at Arendal.

By way of introduction extracts are given from the Presidential Address delivered before the British Association in 1898 by Sir William Crookes, showing the urgent importance of the subject in consideration of the rapid rate of exhaustion of the world's present stock of fixed nitrogen—the great fertiliser for wheat—and it is pointed out that out of the air over each square mile of the earth's surface more saltpetre can be made than is to be found in the whole of Chili. A brief history of the oxidation of nitration by means of electricity includes references to the pioneering work of Priestley and Cavendish (about 1780), to the more recent work of Spottiswoode and Dewar (1880), Crookes (1892), and Rayleigh and Ramsay (1897), and finally to the technical applications developed by Bradley and Lovejoy (1903), and by Kowalski and Moscicki (1904).

The essence of the electrical side of the problem consists in the production of a stable and practical form of high-tension arc in which to effect the oxidation. This the author produces by placing an alternate current arc equatorially between the poles of a powerful electro-magnet. The arc thus formed moves across the electric field with enormous velocity, while its length, and thus its resistance, increases so that the tension is heightened until a new arc forms at the points of the electrodes, and the long outer arc is extinguished. The positive and negative arcs move in opposite directions, and in this way a complete, luminous, circular disc of flame is formed. When the proper conditions are attained, and the arc is stable, one arc only, as shown by oscillograph records, is formed at each reversal of the current. The potential employed is 5000 volts, and the frequency 50. The electrodes, which are 8 m.m. to 1 c.m. apart, are made of copper tubing 15 m.m. in diameter, and are water-cooled; 7·5 per cent of the energy is wasted in this way as heat. The electrodes are removed for repair every three hundred hours.

The disc-flame is enclosed in a special furnace, which is described in the paper. The fire-chamber of this is only 5·15 c.m. wide, and air is driven into the central region by a Root's blower. At Notodden there are three such furnaces, each employing 500 kilowatts. In the new 30,000 H.P. plant, now in course of erection, the furnaces will each absorb from 750 to 850 kilowatts. Figures showing cost of erection and upkeep are given.

The air (75,000 litres per minute at Notodden), which after passing through the furnaces contains about 1 per cent of nitric oxide, discharges its superfluous heat into a steam-boiler, cooling from 700° C. to 200° C., and, finally, at 50° C. it enters the oxidation chambers in which the nitric oxide becomes nitric peroxide. It then passes to the absorption towers to be dissolved in water, forming, finally, 50 per cent nitric acid. The unabsorbed nitric fumes are converted into a fifth, milk-of-lime, tower to calcium nitrite and nitrate, which in turn is completely oxidised to nitrate by means of nitric acid. This nitrate lye, mixed with the bulk of nitric acid, reacts on limestone, and is converted into a solution of neutral calcium nitrate, which may be crystallised out either in the normal or basic form. The yield of the furnaces is given as 500 kilogrms. of anhydrous nitric acid per killowatt-year, but this is a minimum yield. The inclusive cost of production is stated to be £4 a ton, the selling price being £8 a ton; at Notodden about 25s. per E.H.P.-year is paid for power, but the cost is less than half of that.

The author finally discusses the theory of the oxidation of nitrogen in electric arcs, and incidentally he describes experiments made to determine the thickness of the arc threads. According to the simple thermo-chemical theory at every temperature a definite amount of NO is in equilibrium with a fixed mixture of air and nitrogen; at 3000° C., for example, an entire 5 per cent will be nitric oxide. To retain this quantity at a lower temperature the cooling must take place with very great rapidity. The great difficulty in making theoretical calculations is that of knowing the temperature of the arc. The author compares results obtained during a very careful trial run at Arendal with those calculated from Nernst's formula, assuming various temperatures for the arc, and he finally, after allowing for the length of time the maximum temperature is effective, assumes an average temperature of 3200° C. A higher temperature should be arrived at in practice, for the maximum theoretical output coincides with about 5200° C. The paper concludes with an estimate of the number of molecules in the arc that are split up into ions, and suggests comparisons with air ionised by means of radium. It may be that the proportion of gas ionised will be of determinative importance to the chemical equilibrium of gas compounds.

Dr. H. BORNS asked for further information relating to the absorption of the combined gases.

Dr. R. S. HUTTON discussed the figures given relating to power consumption. In reply, the author stated that less than 0·7 per cent of the total energy was absorbed in the magnets, and that in the new works only about 3 per cent of the total power would be used for auxiliary purposes outside the furnaces.

In reply to Dr. R. M. WALMSLEY, the author stated that greater efficiencies than 179 grms. per killowatt-hour had been obtained recently.

Dr. O. J. STEINHART referred to the low cost of water-power given by the author. In reply, it was stated that the power at Notodden for which 25s. per E.H.P.-year was paid cost only 11s.

In reply to Dr. F. M. PERKIN, it was stated that the flow of gas cannot exceed a certain amount, or the flame would be extinguished.

The CHAIRMAN described the careful and elaborate trial to which the process had been put by the Commission referred to in the paper, and which entirely confirmed the claims made by the inventors regarding efficiencies and costs. He alluded to the well-known important work of Prof. Birkeland on the aurora borealis, and on the action of magnetic fields on cathode discharges, and showed how these purely scientific investigations led up to the working out of the present important industrial purposes.

Dr. EUGENE HAANEL, of the Department of the Interior, Ottawa, presented a "*Preliminary Report on the Experiments made at Sault Ste. Marie, under Government Auspices, on the Smelting of Canadian Iron Ores by the Electro-thermic Process.*" The paper was communicated by Mr. F. W. Harbord, F.I.C.

The experiments described were made for the purpose of amplifying the results obtained at La Praz and Livet by the Canadian Commission in 1904, in view of the special conditions obtaining in Canada.

The furnace, which is fully described and illustrated, was of the Héroult type; it absorbed 5000 ampères at 35 to 40 volts (power factor 0·919), being fed from a transformer of 225 kilowatt capacity. The official experiments, of which a selected number are explained in detail with full chemical, electrical, and thermal data, lasted nearly two months, and during that time 150 casts were made, yielding 55 tons of pig-iron. The experiments indicated that under normal conditions about 11·5 tons were produced by an expenditure of 1000 E.H.P.-days: with an improved furnace of, say, 1500 E.H.P. capacity, a figure of 12 tons should, it is stated, be reached. The mean figure provisionally adopted by the Commission was only

7·8 tons per 1000 E.H.P.-days. The consumption of electrode was about 18 lbs. per ton of pig-iron; it was greater for white than for grey iron.

The results obtained are summarised as follows:—

1. Magnetite (which is the chief Canadian ore) can be as economically smelted by the electro-thermic process as hematite.
2. Ores of high sulphur content not containing manganese can be made into pig-iron containing only a few thousandths of 1 per cent of sulphur.
3. The silicon content can be varied as required for the class of pig to be produced.
4. Charcoal, which can be cheaply produced from mill refuse or wood which could not otherwise be utilised, can be substituted for coke as a reducing agent, without being briquetted with the ore.
5. A ferro-nickel pig can be produced practically free from sulphur and of fine quality from roasted nickeliferous pyrrhotite.
6. The experiment made with a titaniferous iron ore containing 17·82 per cent of titanic acid permits the conclusion that titaniferous iron ores up to perhaps 5 per cent titanic acid can be successfully treated by the electric process

The paper concludes with an estimate of Dr. Héroult for a 10,000 H.P. plant capable of producing 120 tons of pig-iron in twenty-four hours.

A paper on "*Electrolysis of Dilute Solutions of Acids and Alkalis at Low Potentials; Dissolving of Platinum at the Anode by a Direct Current*," by George Senter, Ph.D., was taken as read.

When dilute solutions of sulphuric acid and of sodium hydroxide are submitted to electrolysis at a potential below that at which oxygen is evolved in the gaseous form, an oxidising agent is formed in very small amount at the anode. The substance is very stable, and is not destroyed by boiling; it is not hydrogen peroxide.

In the course of the experiments with dilute sulphuric acid, it was observed that traces of platinum went into solution from the anode, although the average current density was only about $1{\cdot}5 \times 10^{-7}$ ampères per sq. c.m.; the bearing of this result on the conclusions of Ruer with regard to the action of simultaneous alternating and direct currents on platinum anodes is discussed.

## CHEMICAL NOTICES FROM FOREIGN SOURCES.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxlii., No. 25, June 18, 1906.

**Researches on Direct Synthesis of Nitric Acid and Nitrates from their Elements at Ordinary Temperatures.**—M. Berthelot.—The author makes a series of researches on the synthesis of nitric acid from its elements at ordinary temperatures under the influence of an electric current obtained from an induction coil with alternate discharges augmented by a 12-volt current of 6 ampères. The reaction seems to take place according to the exact equation $N_2+O_5+H_2O+Aq = 2NO_3H$ dilute.

**Action of Carbonic Oxide on Water-vapour at a Red Heat and of Hydrogen on Carbonic Acid. Application of these Reactions to an Investigation of Volcanic Phenomena.**—Armand Gautier.—When carbonic oxide acts on water-vapour at 1200—1250°, $CO_2$, H, CO, and atmospheric nitrogen result, the numbers showing the reaction (1) $3CO+2H_2O = 2CO_2+2H_2+CO$ to have taken place. This equation does not vary sensibly if the quantity of water introduced is varied. When hydrogen acts on carbonic acid at a high temperature the $CO_2$ is reduced, forming water, (2) $CO_2+3H_2 = CO+H_2O+2H_2$, after which reaction (1) takes place.

**Use of Metallic Oxides as Oxidising Catalysers.**—Paul Sabatier and Alphonse Mailhe.—If vapour of formenic carbide mixed with a current of oxygen is directed on to oxide of copper, the temperature of the oxide being gradually raised at about 200°, an incandescence becomes apparent, which is maintained indefinitely as long as the current of mixed gases is used. The heating can gradually be stopped without interfering with the phenomenon. Oxidation is also produced with permanent incandescence if the copper oxide is replaced by nickel or cobalt oxide. The experiment succeeds with methane as well as with various liquid carbides, pentane, hexane, heptane, &c.

**Reduction of Antimony Selenide.**—P. Chrétien.—When $Sb_4Se_5$ is reduced by adding antimony, two temperatures of fusion are observed, but the two temperatures are of unequal and variable importance. An analysis of the mass shows that there are two solutions of very different concentration. The existence of these two phases is only due to a defective mixture. The author now makes a new series of measurements starting from SbSe, and adding an intimate mixture of finely powdered antimony and selenium. A single temperature of fusion is then noticed, but again starting from the same point and adding increasing proportions of antimony, the two phases appear as before.

**Oxidations due to Air. Problem of the Comparison of Velocities.**—André Job.—The author finds that oxidations by means of air are very difficult to define. Measurements, even when only relative and of simple comparison, are often illusionary. They are only of value if very severe rules are imposed which require very delicate experimental technique. The author worked under the following conditions:—Very violent agitation of the liquid with air in an hermetically sealed apparatus, rigorously constant temperature, &c. By reason of the difficulties and even after numerous experiments he still could not obtain definite concordant results.

**Heterogeneous Equilibriums. Formation of Phosphonium Chloride, Carbamate, and Ammonium Sulphohydrate.**—E. Briner.—The author gives an account of his experiments performed to verify theoretic considerations described in a previous paper (*Comptes Rendus* of May 28th, 1906); the systems $(CO_2+2NH_2)$ and $(NH_3+H_2S)$ being investigated.

**Osmotic Pressure in Hydrochloroferric Colloid.**—G. Malfitano.—When a preparation of hydrochloroferric colloid obtained by heating a 0·5 per cent solution of $Fe_2Cl_6$ for fifteen minutes to 115—120° is filtered, a liquid residue remains. If after keeping the interior pressure constant until the volume reaches a limit, the apparatus is then put under ordinary pressure, leaving the filter in contact at its lower extremity with the liquid filtrate, the latter re-enters the filter and the level rises inside. The author measures the osmotic pressure of such a colloidal solution.

**Copper Steels.**—Pierre Breuil.—The author investigates the properties of copper steels, and finds that the copper considerably raises the hardness of the steel. He investigates two series with varying proportions of copper by means of the Le Chatelier thermoelectric couple.

**Melezitose and Turanose.**—Georges Tanret.—Turanose, $C_{12}H_{22}O_{11}$, is not, as was hitherto believed, able to be decomposed into two molecules of glucose. On hydrolysis it breaks up into one molecule of glucose and one molecule of lævulose. Melezitose, $C_{18}H_{32}O_{16}$, gives, by feeble hydrolysis, a molecule of glucose and a molecule of turanose. It is formed of two molecules of glucose and one molecule of lævulose.

## NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertisement columns.

**Hydrochloric Gas Generating Vessel.**—Can any reader kindly tell me the best firm to apply to for a small vessel generating about 40 lbs. of hydrochloric gas per day of eight hours. Also small centrifugal separator taking 10 lbs. of material in one operation.—H. J.

THE
# DAVY FARADAY RESEARCH LABORATORY
OF
## THE ROYAL INSTITUTION.

*Director:*
Professor SIR JAMES DEWAR, M.A., LL.D., D.Sc., F.R.S.
*Superintendent of the Laboratory:*
Dr. ALEXANDER SCOTT, M.A., D.Sc., F.R.S.

This Laboratory was founded by Dr. LUDWIG MOND, F.R.S., as a Memorial of Davy and Faraday, for the purpose of promoting, by original research, the development and extension of Chemical and Physical Science.

MICHAELMAS TERM.—Monday, October 1, to Saturday, December 15.
LENT TERM.—Monday, January 7, to Saturday, March 23.
EASTER TERM.—Monday, April 15, to Saturday, July 27.

Full information and forms of application can be had from the Assistant Secretary, Royal Institution, Albemarle Street, W.

To prevent delay, Candidates ought to send in their applications for admission during the course of the Term preceding that in which they wish to enter.

# EGYPTIAN GOVERNMENT.

## MINISTRY OF EDUCATION.

The following post at the School of Medicine, CAIRO, is vacant:—

ASSISTANT TO THE PROFESSOR OF CHEMISTRY.

The appointment is for two years, and may be renewed at the end of that time. Applicants should forward copies of testimonials, and such other particulars as are mentioned below.

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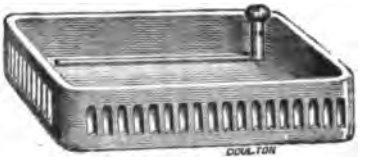

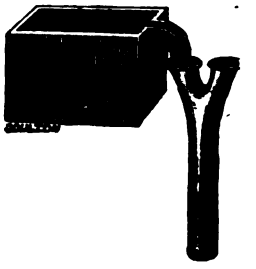

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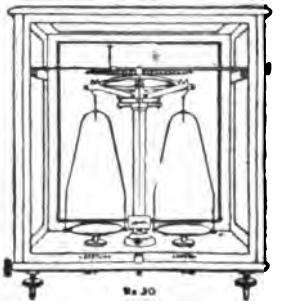

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THE CHEMICAL NEWS.

Vol. XCIV., No. 2435.

## ON THE ULTRA-VIOLET SPECTRUM OF YTTERBIUM.*

By Sir WILLIAM CROOKES, D.Sc., F.R.S.

The rare earth ytterbia was discovered in 1878 by Marignac (*Comptes Rendus*, vol. lxxxvii., p. 578). In 1880 Nilson (*Ber.*, vol. xii., p. 554), in purifying Marignac's ytterbia, found that it contained another earth which he named scandia. Cleve, and more recently his daughter Astrid Cleve, have worked much on ytterbia, and within the last few years M. Urbain has taken up the subject, and has succeeded in purifying ytterbia in larger quantities. During my own work on the fractionation of the rare earths I also have prepared and worked with ytterbia.

Marignac, Nilson, Cleve, and Urbain have each presented me with some of their ytterbia. Nilson's earth, sent in 1886, appears pure. Unfortunately, there was only sufficient to enable me to photograph the part of its spectrum between wave-lengths 2400 and 2580.

Ytterbia is one of the least basic oxides of the yttria group; the order being yttria, erbia, thulia, ytterbia, and scandia; yttria being the most basic and scandia the least. The atomic weight of ytterbium, taking the formula of the oxide, the only one known, as $Yb_2O_3$, is, according to Nilson, 173·01. Miss Astrid Cleve obtained the number 173·11. The salts of ytterbium are colourless and show no spectrum bands by transmitted light.

My ytterbia was prepared from the mixed yttria earths by the old method of partial decomposition of the nitrates by heat. The chief difficulty is to free the ytterbia from the last traces of thulia. The fractionation of the nitrates must go on until a considerable thickness of the fused nitrate shows no trace of the thulium absorption bands at wave-lengths 4700 and 7000. A trace of scandia may still be present, but this earth is very seldom met with. All my tests have failed to show its presence, and Miss Cleve, working with several kilogrms. of ytterbium earths derived from different minerals, also was unable to find scandium in them.

In April, 1904, M. Urbain gave me sufficient of his purest ytterbia to enable me to photograph its complete ultra-violet spectrum. His earth was prepared by the fractional crystallisation of the ethyl-sulphates of crude gadolinite earths (*Comptes Rendus*, vol. cxxxii., p. 136). The subsequent separation is by the fusing nitrate method. This after twenty series of fusions gave in the least basic portions a mixture of ytterbia and thoria, which are easily separated by Wyrouboff and Verneuil's method. This is the ytterbia of which I have photographed the spectrum. It still contains traces of thulia. M. Urbain's more recent method of preparing ytterbia is by fractionally crystallising the nitrates from a slightly diluted nitric acid. In this way he tells me he has succeeded in getting ytterbia free from thulia.

The examination for absorption-bands in a strong solution is a fairly good test for an earth, such as erbia and thulia, giving absorption spectra, but it is not so delicate as an examination of the spark spectrum photographed through a quartz train, for dominant lines which most elements show in some part of their spectrum. For instance, the dominant lines of yttrium are at wave-lengths 3600·9, 3710·4, 3774·5, 4177·7, and 4375·1. The dominant lines of erbium are at 3499·3, 3692·8, and 3906·5. They are, however, not strong, and fortunately the absorption bands of this element are striking and characteristic. The spark spectrum of thulium has only been slightly examined by me, and I do not think it has any strong lines. Its absorption spectrum, as with erbium, is a very characteristic one. The spark spectrum of ytterbium has strong dominant lines at 3289·5 and 3694·4. Scandium has dominant lines at 3572·7, 3614·0, 3630·9, 3642·9, and 4247·0.

The spark spectrum of ytterbium was first examined by Thalen, but only in the visible portion. Exner and Haschek have published a set of measurements of the spark spectrum of ytterbium, from wave-lengths 2116 to 4726 ("Wellenlängen-Tabellen für Spektralanalytische Untersuchungen," F. Deuticke, Leipzig und Wien, 1902). I have found them to be very accurate, and in my photographs I have generally adopted their figures. Occasionally lines are in their list which appear to belong to other elements, and in some cases lines given by them cannot be distinguished in my spectrum.

My photographs were taken with the quartz apparatus already described, the spectrum of pure iron being used as a standard. The ytterbium spark was taken from a strong solution of the nitrate between platinum poles, sufficient self-induction being introduced to eliminate nearly all the air lines. The ytterbium, by this very severe spectrum test, is seen to be not absolutely free from impurities, thulium,* copper, and calcium being present. Thulium is seen by its lines at 3020·7, 3131·4, 3425·2, 3441·6, 3462·4, and 3848·2. Copper is seen by its dominant lines at 3247·7 and 3274·1, and calcium by its dominant lines at 3933·8 and 3968·6.

The platinum lines which are present are easily recognised, and are useful as an additional measure of identification. Besides these a number of fainter and indistinct lines are seen. These may be due to ytterbium, or to traces of hitherto unrecognised impurities.

The wave-lengths of all the recognisable lines of ytterbium are given on the photograph, and also those of thulium, calcium, and copper, but the platinum lines are not marked.

* A Paper read before the Royal Society, June 28, 1906.

* M. Urbain writes, under date May 5th, 1906:—"The ytterbium of which you have taken the spectrum was prepared some years ago. It is impossible to affirm that it does not contain thulium, and the experience I have acquired since these already ancient researches leads me to think it does contain traces. Thulium is very difficult to separate completely from ytterbium, and I have only recently succeeded in doing so. Do not fail to mention that this preparation was obtained by fusion of the nitrates of the rose-coloured yttric earths obtained in the tails of the crystallisation of the ethyl sulphates."

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Continued from p. 26).

*History of the Advent of the New Chemistry.—Thomas Young.*

"Contenting ourselves with enumerating the names of Roger Bacon and Basil Valentine, as the greatest chemists of the thirteenth and fifteenth centuries, and Paracelsus, Agricola, and Libavius, of the sixteenth, we shall hasten to the beginning of the seventeenth, as the true period the commencement of the pneumatic chemistry, under the auspices of Van Helmont, who first distinctly observed the properties of several elastic fluids, which he denominated gases; and more especially of Rey, who, in the year 1630, expressly maintained the absorption of air by metals during their calcination; nor was it much later that Torricelli and Pascal began to investigate the mechanical properties of the air with mathematical precision. About the time of the foundation of the Academy del Cimento, of the Royal Society, and the Parisian Academy of Sciences, which constitutes an era so important in the progress of human knowledge, the most distinguished chemists in

† Delivered at the Royal Institution, May 26th, 1906.

Germany were Glauber, Kunckel, Brandt, Hofmann, Beccher, and Stahl; in France, Homberg, Geoffroy, and the Lemerys; and in England, Boyle, Hooke, Slare, and Mayow; but with regard to the philosophical theory, especially of pneumatic chemistry, the English had advanced far beyond their neighbours, even before the publication of the correct and comprehensive speculations contained in the queries of Newton, which marked the commencement of the eighteenth century, and which may be considered as the basis of the more refined and accurate cultivation of chemical science. In pursuit of these suggestions, the order of chemical attractions appears to have been first distinctly exhibited in a tabular form by Geoffroy, about the year 1718. The idea of a single combustible principle, or phlogiston, is traced to Albertus Magnus, the contemporary of Roger Bacon, and was received from Beccher by Stahl, who advanced in support of it many ingenious experiments; for example, the decomposition of Glauber's salt by charcoal; and this doctrine was almost universally adopted throughout Europe in preference to the more correct views of Boyle, Hooke, and Mayow. The researches of these chemists were, however, in some degree revived by the industrious Dr. Hales, although he was unfortunately misled by the idea that all elastic fluids were essentially the same, and only distinguished by some accidental modifications from the presence of various effluvia. The error of this opinion was clearly and elegantly displayed by Dr. Black, who published, in 1756, a little essay on magnesia and fixed air, which may be considered as the true beginning of the pneumatic chemistry. The earliest labours of Mr. Cavendish are dated in 1765, when he invented the hydropneumatic apparatus, discovered inflammable air, and made very many important experiments on the properties of gases of different kinds. Dr. Priestley followed the steps of Hales and Cavendish with the most distinguished success, and discovered the existence of nitrous gas, nitrous oxyd, and oxygen; and exhibited by means of the mercurial apparatus, muriatic acid, sulphurous acid, and ammonia in a gaseous state. Macquer, Rouelle, Margraff, Pott, and, above all, Bergman, were in the meantime diligently pursuing their refined analyses on the Continent; and Scheele was carrying on a train of investigations much resembling those of Priestley, ascertaining the composition of the atmosphere, and the properties of the fluoric and prussic acids, and the oxymuriatic acid gas. Of all these chemists, Black, Cavendish, Priestley, and Scheele were unquestionably the greatest discoverers; the facts which they had brought forward were in some measure systematised by Lavoisier, to whom our author thinks that 'no other inquirer except Cavendish can be compared for precision of logic, extent of view, and sagacity of induction.' Bayen, in 1774, had shown that the calx of mercury was capable of being rendered metallic without the addition of any inflammable substance, and hence had argued against the agency of phlogiston in the revival of metals in general. In the next year, Lavoisier examined the air afforded by the calx during its reduction, which was already known to Priestley and Scheele, and called it oxygen; he demonstrated also the constitution of the carbonic acid gas, and showed that the nitrous and sulphuric acids derive their properties from the combination of their bases with oxygen. Mr. Cavendish soon after showed the true nature of the basis of the nitric acid, and made a discovery, which is perhaps of greater importance than any single fact which human ingenuity has ascertained, either before or since, that of the composition of water from oxygen and hydrogen. Soon after this, Mr. Berthollet proved that ammonia consists of hydrogen and nitrogen, and many other chemists continued a series of researches, which appeared to illustrate and confirm the doctrine of Lavoisier. The existence of phlogiston was, however, still very ably maintained by Mr. Cavendish in 1784 as the simpler of the two theories by which the phenomena might be explained; and other chemists retained the same opinion for a much longer period. In 1787, the French chemists presented to the public their new system of nomenclature, which certainly contributed in some degree to the faculty of acquiring the science, but still more to the dissemination of the doctrines of the school from which it proceeded."

*Cavendish.—Thomas Young.*

"In 1760 he became a Fellow of the Royal Society, and continued for almost fifty years to contribute to the *Philosophical Transactions* some of the most interesting and important papers that have ever appeared in that collection, expressed in language which affords a model of concise simplicity and unaffected modesty, and exhibiting a precision of experimental demonstration commensurate to the judicious selection of the methods of research, and to the accuracy of the argumentative induction; and which have been considered, by some of the most enlightened historians, as having been no less instrumental in promoting the further progress of chemical discovery, by banishing the vague manner of observing and reasoning that had too long prevailed, than by immediately extending the bounds of human knowledge with respect to the very important facts which are first made public in these communications.

"The splendid career of chemical investigation, which has since been pursued with a degree of success so unprecedented in history, may be said to have been first laid open to mankind by the labours of Mr. Cavendish; although the further discoveries of Priestley, Scheele, and Lavoisier soon furnished, in rapid succession, a superstructure commensurate to the extent of the foundations so happily laid. 'Whatever the sciences revealed to Mr. Cavendish,' says Cuvier, 'appeared always to exhibit something of the sublime and the marvellous; he weighed the earth; he rendered the air navigable; he deprived water of the quality of an element'; and he denied to fire the character of a substance. 'The clearness of the evidence on which he established his discoveries, so new and so unexpected as they were, is still more astonishing than the facts themselves which he detected; and the works, in which he made them public, are so many masterpieces of sagacity and of methodical reasoning; each perfect as a whole, and in its part, and leaving nothing for any other hand to correct, but rising in splendour with each successive year that passes over them, and promising to carry down his name to a posterity far more remote than his rank and connections could ever have enabled him to attain without them.'"

*Priestley.—Prof. Thomson.*

"His discoveries in pneumatic chemistry are so numerous, that I must satisfy myself with a bare outline; to enumerate everything, would be to transcribe his three volumes, into which he digested his discoveries.

"The first of his discoveries was nitrous gas, now called deutoxide of azote, which had, indeed, been formed by Dr. Hales; but that philosopher had not attempted to investigate its properties. Dr. Priestley ascertained its properties with much sagacity, and almost immediately applied it to the analysis of air. It contributed very much to all subsequent investigations in pneumatic chemistry, and may be said to have led to our present knowledge of the constitution of the atmosphere.

"The next great discovery was oxygen gas, which was made by him on August 1, 1774, by heating the red oxide of mercury, and collecting the gaseous matter given out by it. He also immediately detected the remarkable property which this gas has of supporting combustion better, and animal life longer, than the same volume of common air; and likewise the property which it has of condensing into red fumes when mixed with nitrous gas. Lavoisier likewise laid claim to the discovery of oxygen gas; but his claim is entitled to no attention whatever, as Dr. Priestley informs us that he prepared this gas in M. Lavoisier's house, in Paris, and showed him the method of procuring it in the year 1774, which is a considerable time before the date assigned by Lavoisier for his pretended discovery. Scheele, however, actually obtained this gas without any

previous knowledge of what Priestley had done; but the book containing this discovery was not published till three years after Priestley's process had become known to the public.

"Dr. Priestley first made known sulphurous acid, fluosilicic acid, muriatic acid, and ammonia in the gaseous form; and pointed out easy methods of procuring them. He describes with exactness the most remarkable properties of each. He likewise pointed out the existence of carburetted hydrogen gas; though he made but few experiments to determine its nature. His discovery of protoxide of azote affords a beautiful example of the advantages resulting from his method of investigation, and the sagacity which enabled him to follow out any remarkable appearances which occurred. Carbonic oxide gas was discovered by him while in America, and it was brought forward by him as an incontrovertible refutation of the antiphilogistic heory.

"Though he was not strictly the discoverer of hydrogen gas, yet his experiments on it were highly interesting, and contributed essentially to the revolution which chemistry soon after underwent. Nothing, for example, could be more striking than the reduction of oxide of iron, and the disappearance of the hydrogen when the oxide is heated sufficiently in contact with hydrogen gas. Azotic gas was known before he began his career; but we are indebted to him for most of the properties of it yet known. To him, also, we owe the knowledge of the fact that an acid is formed when electric sparks are made to pass for some time through a given bulk of common air; a fact which led afterwards to Mr. Cavendish's great discovery of the composition of nitric acid.

"He first discovered the great increase of bulk which takes place when electric sparks are made to pass through ammoniacal gas—a fact which led Berthollet to the analysis of this gas. He merely repeated Priestley's experiment, determined the augmentation of bulk, and the nature of the gases evolved by the action of the electricity. His experiments on the amelioration of atmospherical air by the vegetation of plants, on the oxygen as given out by their leaves, and on the respiration of animals, are not less curious and interesting."

### "*Lavoisier*."—*Samuel Brown*.

"It was Antoine Laurent Lavoisier who first felt the pressure of the necessity for a renovated theory of chemistry, and at once began to construct it, say rather to woo it from the opening bosom of nature, where it lay ready to come forth at the call of him who knew the word of power. Dumas has triumphantly shown that his countryman had formed the idea of his great revolution at the very outset of his career, and that even before many of the pneumatic discoveries of the Swedish and British phlogistians had been made and published. There can be no manner of doubt, in fact, of the single-handed originality of the French law-giver of chemistry in bringing about that transition, from the era of phlogiston and the cupel to that of oxygen and the balance, which constitutes the turning-point of the history now under review. It is easy and social to speak with effusion about the division of labour and the grandeur of combination; but it seemed generally to be individual men that do the greater business of science and of the world after all. Institutes, academies, royal societies have all been good; but a man like Lavoisier is better than them all. German, British, American associations have their important purposes to serve, and they subserve them well; but an opinion begins to prevail, that in these days we run some danger of being associated to death. Excessive association certainly tends to the production of weakness in the individual unit, if the resulting whole is strong; and it is fortunate that there are some men so unsocial as to dwell apart, drawing inspiration from the quiet past, from the instant universe itself, and from the whispering dawn that is ever arising in the East.

"The Lavoisierian definition of the elemental nature was perfect. It was the first clear conception ever attained to and uttered on the subject. This great law-giver of chemistry became positive, an apt scholar in scientific scepticism, and the admirer of Condillac, defined a chemical element to be nothing more, and nothing less, than a material substance not yet analysable, not yet broken up into simpler forms; in short, a body not yet decomposed, but not, therefore, indecomposable to be called simple for the time being, but not necessarily always to remain in the list of elements; elementary not in an absolute but only in a logical and provisional sense of the term. The metals, the earths, the alkalis, the combustibles, the three gaseous organogens were therefore all registered as elements for the meantime. Davy decomposed the alkalis and earths, proving them to be the oxides of so many new and unheard-of metals. The same chemist, certainly the noblest of the disciples and workmen of Lavoisier, found out the true nature of chlorine, and thereby deprived oxygen of the right to its name; for oxygen had been prematurely chronicled as the acid-gendering element, but chlorine was now discovered to be at once a simple body and an engenderer of acids just as truly as oxygen.

"Iodine, selenium, silicon, titanium, rhodium, and many other substances, equally elementary with oxygen and the old metals, have followed in their turns, and there are now no fewer than some sixty Lavoisierian elements, while there may well be a hundred of them before the century is out. There is no probable limit in truth to the number of this species of elementary principle. If the chemist could but dig deeper into the surface of the world he inhabits, or could be licensed to carry his quarrying gear to the moon, or could even lay hold of the smallest of the Junonian asteroids, to say nothing that might be construed into impertinence concerning the diggings of either Jupiter or Venus, what a pile of such simple bodies he might build up! It should never be forgotten that he has hitherto done nothing but scratch the outside of this old Hertha, and that only to the depth of the thickness of this paper leaf in comparison with a sphere of 2 feet in diameter. In fact and in brief then, there may be six hundred of such elements as ours, just as well as sixty; and almost every year is actually adding a new one to the catalogue. In the meantime, it is to be understood that, from not one of these present sixty, can the hottest furnace, seven times heated, the coldest freezing mixture, the strongest and steadiest galvanic pile, the most thunderous of electric batteries, or the most pungent reagent, were it even fluorine or potassium at a white heat, extract anything but itself. Gold yields gold, iron yields iron, hydrogen yields hydrogen, only gold and iron and hydrogen, to all the solicitations of the fiercest analytics yet known. We stand before the guarded door of nature; the strong bolts will not move; everything fails us, everything!

"Yet it is hard to think that all those sixty creatures are truly simple or elementary. The instinct of humanity revolts against believing that the Maker has departed from His wonted simplicity of procedure in this one part of creation, and flung such a number of unchangeable elements from His immediate hand. Many thoughtful and ingenuous men, indeed, have frankly supposed that it were more like the nature of the Deity, as shown by his interpreted works, to pour forth the unreckonable variety of things from the bosom of one or two principles. Thales and the Greek physicists, Geber and the polypharmists, Roger Bacon and the alchemists, Stahl and the phlogistians, Lavoisier himself, Humphry Davy, Prout, even Berzelius, that man of multitude, have all given more or less explicit expression to this native yearning of the thoughts of the heart of man towards simplicity; that is to say, towards some unity or other underlying the multiplicity of appearances, in this subterranean domain of nature. Man does not love multiplicity, he admires it; but it is unity that he loves, for it moves his imagination while it touches his heart, not only making the whole world kin, but also lessening the distance between that world and God. The next great question in chemistry, then, say rather the per-

petual, and the greatest question in the science, is precisely this:—What is the interior nature of those elements? From the Lavoisierian point of view, in plain earnest, that is the one question of the age. The science bids us ask, and perhaps nature is ready to answer it; but what shall be done, since no known analytical power can move one of those steadfast natures from its propriety? Let synthesis be tried, if analysis has failed; synthesis has never been tried. Be it observed, too, that it is in the highest degree probable that all the sixty present elements are equidistant from simplicity; they are all equally compound (and equally simple, for that matter), if there be any truth in the unanimous testimony of chemical analogy."

*Berzelius, Mitscherlich, Herschel, and Liebig, on the Atomic Theory of Dalton.*

Berzelius, in 1835, said, "The atomic hypothesis was afterwards confirmed by numerous experiments, and we may state without exaggeration that this is one of the greatest steps which chemistry has yet made towards perfection." Mitscherlich, about the same date, said, "that this hypothesis, like every other, must undergo changes in proportion as observations are multiplied. It is possible, although highly improbable, that it may be wholly superseded by another; yet the history of science can adduce scarcely any law, and certainly no theory, which has conducted the inquirer to so many discoveries as this hypothesis; it has served as a guide, not merely in the discovery of the law of definite proportions, but also in many investigations which have given the most important results."

Sir John Herschel, in 1831, said, "The atomic theory, or the law of definite proportions, which is the same thing presented in a form divested of all hypothesis, after the laws of mechanics is, perhaps the *most important* which *the study of nature has yet disclosed.* The extreme simplicity which characterises it, and which is itself an indication, not unequivocal, of its elevated rank in the scale of physical truths, had the effect of causing it to be announced at once, by Mr. Dalton, in its most general terms, on the contemplation of a few instances, without passing through subordinate stages of painful inductive ascent by the intermedium of subordinate laws, such as, had the contrary course been pursued by him, would have been naturally preparatory to it, and such as would have led others to it by the prosecution of Wenzel's and Richter's researches, had they been duly attended to."

Liebig, in 1853, said, "Dalton's atomic theory was a product of the age, and sprang forth in his mind, as a consequence of the discovery of chemical proportions or equivalents. By means of this theory, the numerical results were connected with definite representations concerning the internal nature and constitution of chemical combinations; and thus a number of researches were called forth and prepared for, which had for their object the relations of physical properties to internal composition. I need refer only to isomorphism, to the relations of the specific heat, to the atomic weight, and to those of the boiling-point to composition. Chemistry received in the atomic theory, a fundamental view, which overruled and governed all other theoretical views, to which the ideas of the age respecting chemical forces, affinity, cohesion referred themselves; it was the bond which bound together all other views. In this lies the extraordinary service which this theory rendered to science, viz., that it supplied a fertile soil for further advancement; a soil which was previously wanting. In the most recent investigations concerning the constitution of organic bases, the alcohols and the acids corresponding to the alcohols, we have seen that the groundwork of the Daltonian theory is equally valid for organic bodies. His main law that the properties of compounds are dependent on the nature of their elements, and on the mode and way of their position or arrangement, will always maintain a high value."

(To be continued).

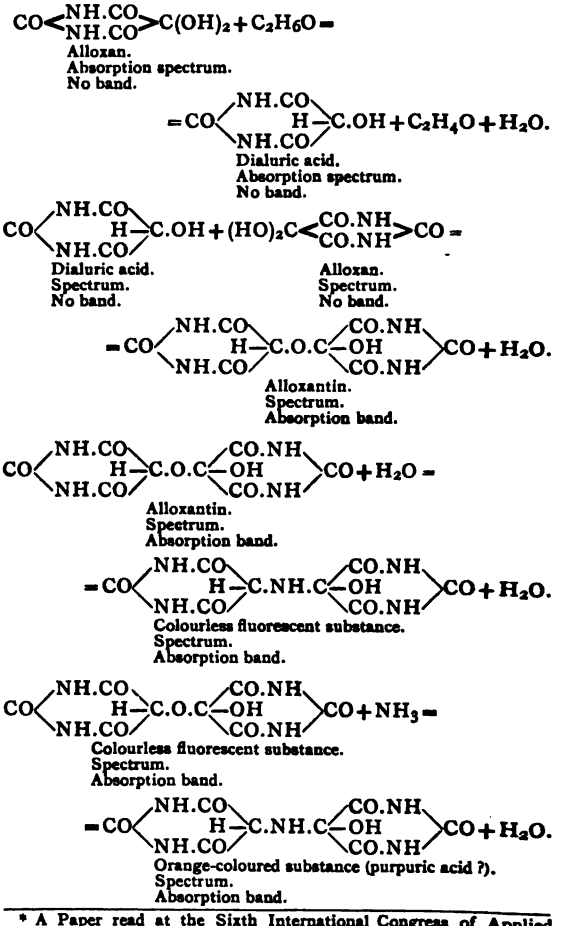
## THE STUDY OF ABSORPTION SPECTRA IN RELATION TO THE CHEMICAL STRUCTURE OF COLOURLESS AND COLOURED SUBSTANCES.*

By WALTER NOEL HARTLEY, F.R.S.,
Royal College of Science, Dublin.

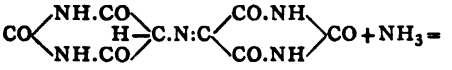
(Concluded from p. 31).

A substance which shows a spectrum with an absorption band in the ultra-violet is a chromogen, and by suitable reactions it may be made to assume colour. The application of this knowledge is of interest to the colour chemist, and therefore a sketch of the results of an investigation recently published (*Chem. Soc. Trans.*, 1905, lxxxvii., pp. 1791—1831) may, I trust, prove an acceptable contribution to this section as explaining the evolution of colour from such colourless materials as the ureides.

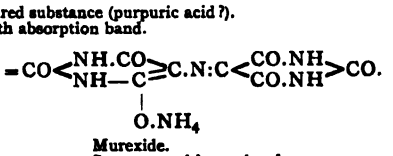
Murexide may be prepared by boiling alloxan, and also alloxantin with absolute alcohol saturated with ammonia gas. The steps in the process are as follows:—One molecule of alloxan is first reduced to dialuric acid by a molecule of alcohol; it then unites with a molecule of alloxan to form alloxantin, water being eliminated. The action of ammonia on the alloxantin causes the formation of a colourless fluorescent, unstable substance, and a scarlet or orange-coloured compound, apparently a purpuric acid. The purpuric acid with aqueous ammonia yields murexide. The following equations will explain this action:—




* A Paper read at the Sixth International Congress of Applied Chemistry, Rome, April 27th, 1906.

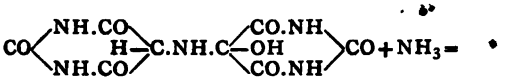


Orange-coloured substance (purpuric acid ?).
Spectrum with absorption band.

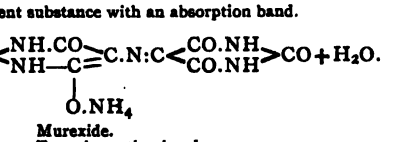


Murexide.
Spectrum with two bands.

The action of the second molecule of ammonia in the boiling solution may receive another interpretation, thus :—

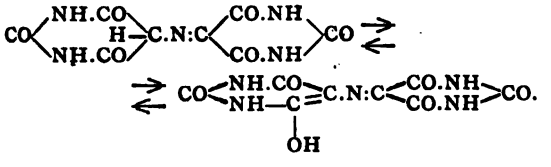


Colourless fluorescent substance with an absorption band.



Murexide.
Two absorption bands.

It is probable that two isomerides are formed in the reaction, both of the nature of purpuric acid, one of which combines with ammonia ($NH_3$) in alcoholic solution, and the other with ammonium hydroxide only ; that is to say, in aqueous solution. The latter corresponds with the orange-coloured substance which has been isolated. The evidence of this is a reaction described by Max Stimmer and Stieglitz, who converted alloxantin entirely into murexide by heating with alcoholic ammonia in sealed tubes for twenty-four hours (Max Stimmer and Stieglitz, *Amer. Chem. Jour.*, 1904, xxxvii., 2686).

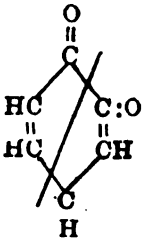


The essential conditions for the formation of a colour, such as murexide, are, first, the linking of two oximino-ketone rings by oxygen or by nitrogen ; secondly, the formation of one or more ethylenic linkings within in one of the rings ; and thirdly, the formation of a salt from this compound.

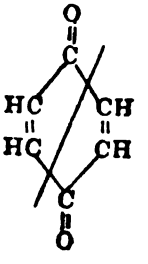
The recent discovery of carbon sub-oxide by Otto Diels and Bertram Wolf (*Ber.*, 1906, xxxix., 689), with the description of its remarkable properties, appears to me of the highest importance in connection with investigations into the relationship between chemical structure and the colour of organic compounds. This substance, obtained from ethyl malonate by the dehydrating action of phosphoric anhydride, is a colourless gas which may be condensed to a volatile liquid boiling at 7°. From its mode of preparation, its reactions, and its vapour density, the authors have assigned to it the formula, —OC:C:CO—. Its most remarkable property is that of spontaneously changing at ordinary temperatures into a coloured substance. The liquid when contained in a sealed tube first turns a feeble yellow colour, then yellow flocks separate, which become darker, and finally acquiring a dark red colour, the contents of the tube become solid. The solid substance when powdered appears almost black, but it readily dissolves in cold water, forming an extraordinarily intense eosine-red solution. What the precise nature of the change is cannot be positively affirmed, but there can be little doubt about its being polymerisation. Certain unsaturated ketones have been recognised as containing the following chromophoric groups :—

(1) —CO.CH:CH.CH:C— (3) —CH:CH.CO.CH:CH—
(2) —CO.CO.CH:CH— (4) —CO.CH:CH.CO—

(Haller and Kostanecki, also Kostanecki and Rossbach, *Ber.*, 1897, xxx., 2947), and it was shown by Wallach (*Chem. Centralblatt*, 1897, i., 373), that the introduction of an ethylenic linking adjacent to a carbonyl group produces a greater absorptive power for the violet rays in a derivative than that possessed by the parent substance, and hence when the latter is colourless the derivative is green or yellow. It is important to note that the substance need not be derived from an aromatic nucleus, since Wallach's observations were made on open chain ketones, and also, if the carbon atoms on both sides of the C:O group are attached to the rest of the molecule by ethylenic linkings, a still stronger colour is exhibited by the compound. Now in any ring structure this may more easily occur than in an open chain compound, and it has been pointed out that *o*-quinones have the same atomic groupings as the chromophores (1) and (2), and the *p*-quinones that of (3) and (4). Moreover, the chromophore —CH.C:O.CH:C— of the unsaturated ketone $C_6H_5.CH:CH.C(:O).C_6H_5$, or benzylideneacetophenone, not only occurs twice in the ring structure of the *o*- and *p*-quinones, but in fact both substances are entirely composed of this chromophore, as may be seen by dividing their structural formulæ by a diagonal line.



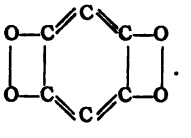
*o*-Quinone



*p*-Quinone.

The importance of the ethylenic linking in conjunction with the carbonyl group is also exemplified in murexide, in which the double linking of the atoms results from the condensation of two ureides into one diureide.

The carbon suboxide is manifestly a chromogen —O.C:C:C.O— and if one may be allowed to deduce a constitutional formula for the red substance into which it spontaneously changes, there is reason to believe on the evidence of the foregoing facts that it is a cyclic compound with the following structure :—



As it contains no hydrogen, it is a most interesting substance in its relations to colour and chemical structure.

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**Refractive Index of Bodies Dissolved in Solvents other than Water.**—C. Chéneveau.—The author makes a series of determinations of refractive indices and densities of solutions containing one salt and one liquid other than water. His experiments were made with one of the salts LiCl, $CaCl_2$, $CuCl_2$, $SnCl_2$, $MgCl_2$, dissolved in ethylic alcohol, LiCl in methylic alcohol, $ZnCl_2$ in ethylic ether, and $NH_4Cl$ in glycerin.—*Comptes Rendus*, cxlii., No. 26.

## THE COAL-TAR COLOUR JUBILEE.

The Theatre of the Royal Institution on Thursday morning presented an appearance which fully justified the decision of the meeting held at the Mansion House in February last, to pay all possible honour to Sir William Perkin, the father of the coal-tar colour industry, now that fifty years have elapsed since his memorable discovery. The place was as full as though the audience had gathered for a fashionable Friday evening, and the first few rows of benches were filled with delegates from nearly every part of the civilised world, gathered together to present their respects, their congratulations, their medals, and their addresses to the veteran hero of the great scientific festival. Happily for the effect of the gathering the somewhat funereal phalanx of black coats in the front was cheerfully framed by variegated colour, for ladies (of whom few can have attended the birth of the great discovery by virtue of which their costumes had been brightened), had assembled in large numbers to grace the occasion, which might otherwise have been all but too impressive in its solemnity. It seems to have occurred to only a few of them to robe themselves in the colour specially appropriate to the day, but the gentlemen who played leading parts in the performance were decorated with rosettes of mauve ribbon, and Professor Meldola, the Master of the Ceremonies, had conscientiously embellished his shirt-front with a mauve tie.

Sir William Perkin himself was conducted at eleven o'clock punctually, when the theatre was already thronged, to the chair of honour in front of the table, while Professor Meldola conducted the proceedings from the usual station of the lecturer. And then, when the roar of applause with which Sir William Perkin's entry was greeted had gradually died away, the proceedings began, and for two solid hours the gallant knight received volleys of glowing compliment in the name of all the scientific societies of Europe and America which had been able in any way to associate themselves with the appreciation of his great achievement. The addresses were so numerous that it is impossible in this brief record of the proceedings to enumerate them in detail. Professor Meldola, of course, began by presenting Sir William with the portrait painted, according to the decision of the February meeting, by Mr. Cope, A.R.A., the work in question hanging up on the screen behind. Beneath it, on a pedestal, was exhibited a replica of the marble bust of Sir William, to be set up in the rooms of the Chemical Society. Professor Emil Fischer, of the Deutsche Chemische Gesellschaft, followed on immediately with a tribute, in German, to the world-wide importance of Sir William's work, presenting him, in the name of the society he represented, with the Hofmann Medal. Those of the audience who understood the language were prompt to applaud its points, and perhaps in some cases the applause was echoed by those who did not understand. But before the meeting was over the many German speeches delivered had so familiarised the audience with the sound of the words "herzliche Glückwünsche" that these, at all events, could readily be picked out by the hearers.

Sir William himself spoke at some length in reply, both to Prof. Fischer and Prof. Haller, who presented him —on behalf of La Société Chimique de Paris—with the Lavoisier Medal. To Hofmann both he and others referred in terms of enthusiastic admiration, whilst Sir William himself contrived to variegate the somewhat monotonous, however gratifying, flavour of the proceedings with little anecdotes of his early scientific recollections. As the morning wore away, it became gradually impossible for him to do more than express in a few words the thanks that were due to the addresses that came pouring in from all sides, until the table with which he had been provided for the storage of his trophies was piled with rolls of paper, bound books, and documents representing degrees of foreign universities conferred upon him on this auspicious occasion. Not the least important of the paper rolls was handed to Sir William by Lord Kelvin on behalf of the Royal Society.

The address of the Chemical Society was delivered by Professor Meldola himself, its President, who described how Sir William was one of the oldest members of that Society, having joined soon after the date of his famous discovery. For seventeen years he had been its Secretary, and for two its President. And, again, pleasant recollections of the past were evoked by Dr. Divers (who offered congratulations on behalf of the Society of Chemical Industry), he himself, as it happened, having been a schoolfellow of Sir William's and his companion at the earliest stage of their chemical studies. At last the proceedings were brought to a conclusion by a comprehensive speech from Sir William himself, who moved from his previous position to the lecturer's place behind the table, and told stories of his first familiarity with that historic theatre in which he heard Faraday's lectures when he was a boy of fourteen. How little at the time could he have foreseen that only a few years later he would lecture there himself on a discovery of his own destined to prove of world-wide importance; how still less could he have dreamt that fifty years later he would be the honoured centre of that brilliant gathering. With graceful taste he reminded his audience that to others besides himself the success of his work was due; above all to his father, who had provided the means with which he established the factory where aniline dyes were originally produced. He dwelt on the satisfaction he felt in thinking that his work had contributed to provide employment for a vast army of working people, and thus had contributed to confer those benefits on mankind that constituted the highest rewards of scientific achievement. Incidentally he explained that in the beginning the silk dyers of France took very cordially to the new mauve dye, while at first the firms in this country connected with cotton dyeing held aloof. Then, by degrees, the French calico-printers realised the importance of the new discovery and began to adopt it freely, followed by our own more lethargic countrymen. As Professor Green, the Secretary of the Jubilee, pointed out, the Royal Institution was not merely a place appropriate to the celebration in progress, in all the world no place more fitting could have been found.

And thus the demonstration, saved by its genuine cordiality of feeling from growing tedious, came to a happy conclusion as regards its initial phase.

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In the evening, a Dinner at the Whitehall Rooms closed the day's proceedings in a highly agreeable fashion. The Chair, of course, was taken by Professor Meldola, who had the guest of the evening on his right and on his left H.S.H. Prince Wilhelm zu Stolberg-Wernigrode, representing the German Embassy. Lord Halsbury gave a pleasant tone to the oratory in proposing "The Rulers of Foreign Nations," whom he humorously congratulated on minding their own business for the most part in the present age of the world. Mr. Haldane, the Secretary of State for War, proposed "The Health of Sir William Perkin," dwelling on the cosmopolitan aspect of science, which operated to render the present international gathering a demonstration in honour of a great individuality belonging to the world of Science as a whole. For want of talents for organisation on our part, it might be that the coal-tar colour industry had flitted across the North Sea, but he took credit for the practical genius of the English people, which enabled them, though they "muddled" matters in the beginning, to "muddle through" at all events in the end.

Sir William Perkin's reply dealt at some length with his earlier work, when it was not thought well for men of science to be concerned with practical industry. He defended the principle that original research should be the inspiration of manufacture.

About 170 guests enjoyed the admirably appointed banquet and the unusual intellectual value of the speeches which followed.

# PROCEEDINGS OF SOCIETIES.

## CHEMICAL SOCIETY.

*Ordinary Meeting, July 5th, 1906.*

Prof. R. MELDOLA, F.R.S., President, in the Chair.

CERTIFICATES were read for the first time in favour of Messrs. Reginald de Vere Cornwall, Medical and Public Health Dept., Salisbury, Rhodesia, S. Africa; Henry Ernest Crocker, 452, Slade Road, Gravelly Hill, Birmingham; James Herbert Dinwoodie, Johannesburg; Gopal Chandra Sen, M.A., 23, Bond Street, Leeds.

A ballot for the election of Fellows was held, and the following were subsequently declared duly elected:—Shelton Gottlieb Agar; Robert Anderson; Percy Corlett Austin, M.A.; Arthur John Berry; William John Bowis, Ph.D.; Harold Calam, B.Sc.; John Denton; Lionel John Drinkwater; Bertie James Eaton; Bernhard Flürscheim, Ph.D.; Reginald William Malyon Gibbs, B.Sc.; Thomas William D. Gregory; Edgar Percy Hedley; Charles H. Hertz, Ph.D., Ph.B.; Arthur Edwin Hill; Frederick Gowland Hopkins, M.A., M.B., D.Sc., F.R.S.; John Gerard Hughes; Ernest Arthur Jenkinson; Thomas Macdonald; Frederick James Martin; Herbert Arthur Mills; William Rest Mummery; Arthur Charles Palmer, B.Sc.; Leonard Edward Beard Pearse; Harold Lawson Pendlebury; Percy George Pennymore; Samuel Shrowder Pickles, B.Sc.; Thomas Ebenezer Pye; Walter Hansen Rawles; Frederick John Salmon; Surendra Prasad Sanyal, D.Sc.; Willie Macro Seaber, B.Sc.; John Senior; Arthur Burton Shepherd, B.Sc.; Allan Sime; Fred Smith; Emanuel George Streimer; Richard Lumley Treble, B.Sc.; Robert Hutchison Turnbull; James Neil Watts; Charles Wightman; Edward Jocelyn Wortley; Henry Wren; George Young, B.A., B.Sc.

Of the following papers, those marked * were read:—

*132. "*Saponarin; a New Glucoside Coloured Blue with Iodine.*" By GEORGE BARGER.

Dissolved in the cell sap of the leaf epidermis of various plants, there occurs a substance which is coloured blue by iodine, and which is known to botanists as "soluble starch." This substance has been isolated from *Saponaria officinalis*, and is a glucoside; the name saponarin is suggested for it.

*Saponarin* crystallises in microscopic needles melting at 231—232°, and having the composition $C_{21}H_{24}O_{12},2H_2O$. The glucoside dissolves in alkalis with a yellow colour, gives with ferric chloride a reddish brown coloration, and with iodine a substance closely resembling that formed from starch.

*Ennea-acetyl* saponarin, $C_{21}H_{15}O_{12}(C_2H_3O)_9$, melts at 183—185° and crystallises in needles.

Acids hydrolyse saponarin, thus:—

$$C_{21}H_{24}O_{12}+H_2O=C_6H_{12}O_6+C_{15}H_{14}O_7,$$

yielding glucose and vitexin, a colouring matter obtained by A. G. Perkin from a New Zealand dye wood (*Trans.*, 1898, lxxiii., 1030, and 1900, lxxvii., 416).

At the same time another colouring matter is formed, apparently isomeric with vitexin, or closely related to it, for which the name saponaretin is suggested. Vitexin and saponaretin both yield phloroglucinol and *p*-hydroxyacetophenone on boiling with caustic potash. Molecular weight determinations of vitexin and of acetyl vitexin prove that Perkin's formula, $C_{21}H_{20}O_{10}$, must be changed to $C_{15}H_{14}O_7$. Vitexin differs therefore from apigenin by two molecules of water, and probably is a flavanone derivative containing either a reduced pyrone ring or a reduced phloroglucinol nucleus. It would be a representative of a new class of colouring matters to which scoparin, which Perkin regards as methoxy-vitexin, would also belong.

DISCUSSION.

The PRESIDENT asked whether the new glucoside was widely distributed in the vegetable kingdom, and whether it was contained in any considerable quantity in any particular plant. He also asked whether the isomeride of vitexin was, in the author's opinion, to be regarded as a natural product, or whether it resulted from the isomerisation of vitexin during the hydrolysis of the glucoside. He considered that Dr. Barger had satisfactorily established the identity of the product of hydrolysis of his glucoside with vitexin, and that he had also established the formula of the latter compound. He considered that the author had made an important contribution to plant chemistry.

Mr. GRANT HOOPER said that in the microscopic examination of vegetable substance, traces of what had hitherto been regarded as soluble starch were not infrequently observed. He would like to know whether Dr. Barger had detected and identified the interesting glucoside which he had just shown them in substances other than those from which he had isolated the new compound.

Dr. BARGER, in reply, said that saponarin, which is optically active, occurs in about twenty plants; one of the richest of these, namely, *Saponaria*, contains less than 1 per cent of the weight of dry leaves. Saponaretin is a product of secondary decomposition; vitexin is formed from the pure glucoside.

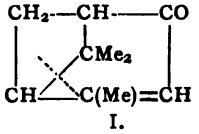
*133. "*The Constitution of Umbellulone.*" By FRANK TUTIN.

The ketone, umbellulone, was isolated from the essential oil of *Umbellularia Californica* by Power and Lees (*Trans.*, 1904, lxxxv., 629), who showed it to possess the formula $C_{10}H_{14}O$.

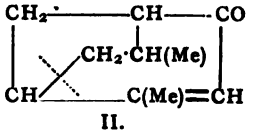
The behaviour of umbellulone towards certain reagents was further studied by Lees (*Trans.*, 1904, lxxxv., 639), and its investigation has been continued by the present author.

Umbellulone, on oxidation, yields a *saturated keto-acid*, $C_9H_{14}O_3$ (m. p. 102°), called *umbellulonic acid*, which, on distillation under suitable conditions, is partially converted into an *unsaturated lactone*, $C_9H_{12}O_2$ (b. p. 217—220°). This lactone, on hydrolysis, yields umbellulonic acid, and is produced by the elimination of water from the enolic modification of the keto-acid. On oxidation, a polymethylene dicarboxylic acid, *umbellularic acid*, $C_8H_{12}O_4$ (m. p. 120—121°), is obtained, which is remarkably stable.

By the bromination of umbellulone, and subsequent distillation of the products, *p*-cymene was obtained, together with substances containing bromine. It would therefore appear that the molecule of umbellulone has a structure capable of yielding this hydrocarbon without undergoing any profound change. The only formulæ which offer a satisfactory explanation of the behaviour of umbellulone on oxidation and on bromination are the following:—




I.




II.

Both these substances, through the rupture of the bridge by the addition of hydrogen at the point indicated by the dotted line, would give compounds capable of yielding *p*-cymene. Formula I. represents a keto-pinene, which would yield, on oxidation, a dimethyltetramethylene dicarboxylic acid, identical or stereoisomeric with the norpic acid obtained by the oxidation of pinene. On the other hand, the compound represented by Formula II. would yield 1-methylpentamethylene 3:5-dicarboxylic acid.

It is considered most probable that Formula II. represents the constitution of umbellulone.

DISCUSSION.

Dr. POWER congratulated Mr. Tutin on the accomplishment of this excellent work. He thought the evidence brought forward was so complete as to leave no doubt respecting the correctness of the constitutional formula

assigned to umbellulone by Mr. Tutin. It was of interest to note that only one other ketone possessing the same empirical formula as umbellulone, namely, carvone, had been observed to occur in nature, but this had a very different constitution.

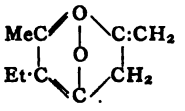
*134. "*The Action of Ethyl Iodide and of Propyl Iodide on the Disodium Derivative of Diacetylacetone.*" By ALEXANDER WILLIAM BAIN.

As the result of the action of ethyl iodide on the disodium derivative of diacetylacetone, suspended in alcohol, the following substances have been obtained :—

1. Dimethyldiethylpyrone, $C_{11}H_{16}O_2$ (m. p. 64°).
2. Dimethylethylpyrone, $C_9H_{12}O_2$ (m. p. 58°).

Each forms a hydrochloride and a platinichloride.

3. Diethyldiacetylacetone, $C_{11}H_{18}O_3$.
4. A compound, $C_9H_{12}O_2$ (m. p. 66—67°, b. p. 289°), isomeric with dimethylethylpyrone, to which the formula—



ascribed. This compound on boiling with concentrated hydrochloric acid yields dimethylethylpyrone hydrochloride, and by the action of sodium hydroxide solution is changed into an orcinol derivative.

By the action of propyl iodide on the disodium derivative of diacetylacetone, the author has obtained dimethylpropylpyrone, $C_{10}H_{14}O_2$, and also an isomeric substance which possesses similar properties to the corresponding ethyl compound.

135. *A Possible Source of Error in Stas's Nitrogen Ratios.*" By ROBERT WHYTLAW GRAY.

Stas's higher value for the atomic weight of nitrogen is supported by very little evidence.

Not only do the researches of Rayleigh, Leduc, D. Berthelot, Guye, and the author confirm the lower value, but an indirect comparison of the atomic weights of nitrogen and silver from the results of Marignac, Scott, and Richards leads to the same result.

By assuming similar errors in the ratio Ag : $NH_4Cl$ and Ag : $NH_4Br$ of Stas as those found for the ratio Ag : NaCl by Richards and Wells, the value for nitrogen deduced is 14·011. The possible sources of error in the other ratios are discussed.

136. "*Electrolytic Oxidation.*" By HERBERT DRAKE LAW.

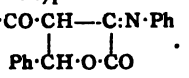
On oxidising benzoin by the electrolytic method, three products are formed, namely, benzil, benzaldehyde, and benzoic acid, as shown by the following equations :—

$$C_6H_5.CH(OH)\cdot COC_6H_5 + O = C_6H_5\cdot CO\cdot COC_6H_5 + H_2O,$$
$$C_6H_5\cdot CH(OH).COC_6H_5 + O = C_6H_5\cdot CHO + C_6H_5\cdot CO_2H.$$

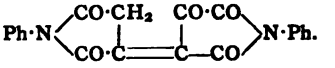
In addition to these, however, a certain amount of tarry matter is always obtained. This formation of complex tarry matter is a property of high potential discharge at the anode, and always takes place in the case of unsaturated compounds. The amount of any of these products which is formed is influenced very largely by the conditions of the experiment. Thus, strongly acid solutions promote the formation of tar, but none is observed when the anodic discharge is kept low. Similar experiments conducted with compounds resembling benzoin gave results agreeing with the above. Thus, cuminoin on being oxidised electrolytically forms cumic acid, cuminol, and tar. Furoin forms furil and tar, benzfuroin gives benzoic acid and tar, whilst anisoin and piperonyloin yield nothing but complex resinous matter of unknown constitution.

137. "*The Ethyl Esters of Acetonyloxalic and Acetophenyloxalic Acids and the Action of Ethyl Oxalate on Acetanilide and its Homologues.*" By SIEGFRIED RUHEMANN.

The research was suggested by a note of Claisen's (*Ber.*, 1891, xxiv., 128) that ethyl sodioacetonyloxalate, on boiling with glacial acetic acid, yielded the sodium compound possessing the empirical formula $C_5H_3O_3Na$. This is violet, as is the substance which Ruhemann and Merriman (*Trans.*, 1905, lxxxvii., 1383) obtained in the course of their investigation on the reaction between phenylpropiolyl chloride and sodioacetylacetone. The compounds which are produced by the condensation of aromatic aldehydes with the ethyl esters of acetonyloxalic and acetophenyloxalic acids react with aniline and its homologues to yield yellow substances, which are constituted according to the type :—



With the object of ascertaining whether a relationship exists between these yellow substances and xanthoxalanil, which W. Wislicenus and Sattler (*Ber.*, 1891, xxiv., 1245) obtained, although in an impure form, from acetanilide and ethyl oxalate, the author has repeated the experiments of these chemists, and has prepared xanthoxalanil in a pure state by crystallisation from nitrobenzene ; its constitution is expressed by the formula—



Similar compounds have been prepared by using, instead of acetanilide, aceto-*p*-toluidide (see Wislicenus and Sattler, *loc. cit.*), aceto-*o*-toluidide, and aceto-α-naphthalide. These substances differ from each other, especially in colour and solubility. Xanthoxalanil in deep orange and sparingly soluble in nitrobenzene xanthoxalo - *p* - toluidide, $C_{22}H_{16}O_5N_2$, is lighter in shade and more soluble, whilst the corresponding ortho-compound is canary-yellow and readily dissolves in this solvent ; finally, xanthoxalo-α-naphthylanil, $C_{28}H_{16}O_5N_2$, is also yellow, but dissolves in glacial acetic acid.

138. "*An Oxidation Product of Indigotin.*" By ARTHUR GEORGE PERKIN.

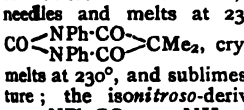
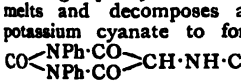
It has been shown by Sommaruga (*Annalen*, 1879, cxcv., 305) that, on sublimation under reduced pressure, refined natural indigo yields pure indigotin ; again, Bloxam (*Trans.*, 1905, lxxxvii., 982) has found that this is the case with the commercial synthetical product. With limited access of air, however, pure indigotin and also these commercial varieties give a small quantity of a yellow sublimate which crystallises in needles, m. p. 258—259°, is very sparingly soluble in alcohol, and can be distilled without appreciable loss. It appears to have the formula $C_{15}H_8O_2N_2$ (found, C = 72·59 ; H = 3·17 ; N = 11·59 per cent), is very resistant to acid oxidising agents, but on boiling with strong potassium hydrate solution gives anthranilic acid. When treated in boiling glacial acetic acid solution with hydriodic acid, an unstable *hydriodide*, forming colourless, prismatic needles (found, N = 7·42 per cent) is produced ; this, on treatment with water, splits off hydriodic acid, and is re-converted into the substance $C_{15}H_8O_2N_2$ ; it is therefore probably the salt of an unstable reduction product of the latter. On reduction with tin and hydrochloric acid, a *compound*, $C_{15}H_{12}ON_2$ (found, C = 76·33 ; H = 5·34 ; N = 11·88 per cent), crystallising in colourless needles, m. p. 190—193°, is formed, which on oxidation is re-converted into the substance $C_{15}H_8O_2N_2$. A trace of indole is also formed during the reduction. By the prolonged action of hydriodic acid, a compound crystallising in yellow needles, m. p. 200—203°, is produced, which can also be re-oxidised to the original product. The author hopes to devise a better method for preparing this yellow compound, as hitherto, with much labour, only 8 grms. of the pure substance could be obtained from 2 lbs. of indigo.

139. "*Indigo-yellow.*" By ARTHUR GEORGE PERKIN.

In a previous communication (*Proc.*, 1904, xx., 172) it was shown that the yellow colouring matter usually present

in Java indigo is kampherol. Examination has now shown that it is derived from a glucoside present in the leaves of the Java and Natal indigo plants (*Indigofera arrecta*), which is probably hydrolysed during the fermentation process. The material employed was chiefly the air-dried Natal leaf. This glucoside, for which the name *Kampheritrin* is proposed, has the formula $C_{27}H_{30}O_{14}$ (found, after being dried at 100°, C = 56·00; H = 5·27 per cent); the air-dried substance contains 3½ mols. of water (found, $H_2O$ = 9·79 per cent). It crystallises in colourless needles, which are sparingly soluble in water, is very nearly devoid of tinctorial properties, and, when heated, congeals together at 190—192°, and melts at 201—203°. It is hydrolysed by acids according to the equation $C_{27}H_{30}O_{14} + 4H_2O = C_{15}H_{10}O_6 + 2C_6H_{14}O_6$ into kampherol (found, $C_{15}H_{10}O_6$ = 49·19 per cent) and rhamnose, identified by means of its osazone. Analyses of the kampherol thus obtained, m. p. 275—277° (found, C = 63·01; H = 3·68 per cent), and its acetyl compound, m. p. 181° (found, C = 60·77; H = 4·43 per cent), were made for purposes of confirmation. By the method employed, 1·5 per cent of the glucoside was isolated, but considerably more of this is really present, as 2 per cent of an impure kampherol contaminated with a reddish brown substance, probably the so-called "indigo-brown," could be obtained by hydrolysing the aqueous extract of the leaf.

140. "1 : 3-*Diphenylbarbituric Acid and some Coloured Derivatives. Synthesis of* 1 : 3-*Diphenyluric Acid.*" By MARTHA ANNIE WHITELEY.

1 : 3-*Diphenylbarbituric acid*, $CO<^{NPh\cdot CO}_{NPh\cdot CO}>CH_2$, prepared by heating malonyl chloride and carbanilide or malonic acid, phosphorus oxychloride and carbanilide in chloroform solution, forms colourless prismatic needles and melts at 238°; the *dimethyl* derivative, $CO<^{NPh\cdot CO}_{NPh\cdot CO}>CMe_2$, crystallises in colourless needles, melts at 230°, and sublimes at a slightly higher temperature; the iso*nitroso*-derivative (*diphenylvioluric acid*),  , crystallises in colourless needles, melts and decomposes at 227°, and yields the red or violet salts characteristic of this type of compound; the *potassium*, *aniline*, and *piperidine* salts were prepared; the *acetyl* derivative, $C_{16}H_{10}O_3N_3\cdot OAc$, crystallises in colourless prisms and melts at 245°. 1 : 3-*Diphenyl-5-aminobarbituric acid* (1 : 3-*diphenyluramyl*), obtained by reducing diphenylvioluric acid, forms colourless crystals, melts and decomposes at 195°, and condenses with potassium cyanate to form 1 : 3-*diphenyl-ψ-uric acid*, $CO<^{NPh\cdot CO}_{NPh\cdot CO}>CH\cdot NH\cdot CO\cdot NH_2$, which crystallises in colourless prisms, melts and decomposes at 217°, and on boiling with hydrochloric acid yields 1 : 3-*diphenyluric acid*,  , which crystallises in colourless needles, softens at 238°, but does not melt at 306°.

1 : 3-Diphenylbarbituric acid condenses readily with aromatic aldehydes or diazonium chlorides, and the resulting compounds are of a bright yellow or orange colour. 5-*Benzylidene*-1 : 3-*diphenylbarbituric acid*, $CO<^{NPh\cdot CO}_{NPh\cdot CO}>C{:}CHPh$, forms pale yellow prismatic needles from most of the ordinary solvents, crystallises from acetone or ethyl acetate in a mixture of colourless and yellow needles, each form melting sharply at 214°, and yielding on reduction 5-*benzyl*-1 : 3-*diphenylbarbituric acid*; 5-*cinnamylidene*-1 : 3-*diphenylbarbituric acid*, $CO<^{NPh\cdot CO}_{NPh\cdot CO}>C{:}CH\cdot CH{:}CHPh$, forms bright yellow needles and melts and decomposes at 268°. 1 : 3-*Diphenylalloxanphenylhydrazone*, $CO<^{NPh\cdot CO}_{NPh\cdot CO}>C{:}N\cdot NHPh$, forms bright yellow needles and melts and decomposes at 264°; 1 : 3-*Diphenylalloxan*-p-*nitrophenylhydrazone*, $CO<^{NPh\cdot CO}_{NPh\cdot CO}>C{:}N\cdot NH\cdot C_6H_4\cdot NO_2$, forms well-developed orange prisms and melts at 274°; 1 : 3-*diphenylalloxanbenzyl*-p-*nitrophenylhydrazone*,—

$$CO<^{NPh\cdot CO}_{NPh\cdot CO}>C<^{CH_2\cdot Ph}_{N{:}N\cdot C_6H_4\cdot NO_2}$$

or—

$$CO<^{NPh\cdot CO}_{NPh\cdot CO}>C{:}N\cdot N<^{CH_2\cdot Ph}_{C_6H_4\cdot NO_2},$$

from 5-benzyl-1 : 3-diphenylbarbituric acid and diazotised *p* nitraniline, crystallises in beautiful yellow prisms and melts and decomposes at 180°. *Alloxanphenylmethylhydrazone*, $CO<^{NH\cdot CO}_{NH\cdot CO}>C{:}N\cdot NMePh$, from alloxan and phenylmethylhydrazone, crystallises in brick-red hexagonal plates, which melt and decompose at 189—190°.

(To be continued).

## NOTICES OF BOOKS.

*German Grammar for Science Students.* By W. A. OSBORNE, M.B., D.Sc., and ETHEL E. OSBORNE, M.Sc. London and New York: Whittaker and Co. 1906.

THE object of this grammar is to assist the student in acquiring such a knowledge of German as shall enable him to read articles and treatises on scientific subjects in that language. The authors have limited themselves to the production of a guide to the translation of German into English, and have introduced only such grammatical rules as are indispensable for the purpose. The method agrees closely with that adopted in the generality of elementary grammars, with the difference that the vocabulary consists chiefly of scientific words instead of those used in general conversation. The syntactical peculiarities of the language are explained as far as possible, and the later exercises contain some sentences of average difficulty, although this part of the book might with advantage be somewhat extended. Special stress is laid upon chemistry, and an appendix gives lists of words used in this and other sciences, with their English equivalents; these lists will be found very useful in supplementing a dictionary, and with the help of this book an average student ought rapidly to acquire a sufficient knowledge of German to enable him to read the language with comparative ease.

*Preservatives in Food and Food Examination.* By JOHN C. THRESH, M.D. (Vic.), D.Sc. (Lond.), F.I.C., and ARTHUR E. PORTER, M.D., M.A., (Cantab). London: J. and A. Churchill. 1906.

THE preservation of foods by various means is treated very fully in this book, and from the data at their disposal the authors conclude that the evils ascribed to the use of preservatives have been greatly exaggerated. Part I. opens with a discussion of methods of preserving, and in it chemical preservatives are criticised from the point of view of their applicability in different cases. In the second part the principal foods which are subjected to preservative processes are considered; for instance, milk, butter, alcoholic and other beverages; while Part III. deals with the addition of colouring matters to foods. The legal aspect of the question is then discussed at some length, while not the least valuable section of the book is that devoted to the description of methods of detecting and estimating impurities and adulterations. The report of the Departmental Committee appointed in 1899 by the President of the Local Government Board to inquire into the question is contained in an appendix, and there is also a short note on the law and practice in certain foreign countries and the colonies as to preservatives and colouring matters in food.

The book will be found of considerable value to the analytical chemist and medical officers of health. Those interested in the preparation of articles of food, and even the general public, might derive some benefit from its perusal.

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*A Handbook for Cane-sugar Manufacturers and their Chemists.* By Guilford L. Spencer, D.Sc. Fourth Edition. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1906.

The fourth edition of this book contains much new matter, and it now includes a description of the sugar manufacturing processes, with which the chemist should be familiar, while the analysis of the various products is carefully described, many valuable practical suggestions being interspersed throughout the text. The descriptions of the use of the polariscope are particularly full and clear, and even chemists with very little experience should find no difficulty in manipulating it if they follow exactly the author's directions. The method of analysis of molasses cattle-food is indicated, and a useful set of tables is given, including both those employed by general chemists and also those to which the sugar chemist has constantly to refer. The book will be found indispensable in sugar laboratories, the fourth edition being a great advance on those previously issued.

---

*Water Softening and Treatment.* By William H. Booth. London: Archibald Constable and Co., Ltd. 1906.

The author of this book is an acknowledged authority in the engineering world, and has, moreover, had much experience in the arrangement of water softening plant, so that he is well qualified to produce a comprehensive work on the subject. The book is intended for both steam users and dyers, and the first part of it gives a full account of the treatment of water by softening, oil separation, and filtering; the apparatus in general use for softening is described at some length, and the analysis of water is discussed; this seems unnecessary in a book of this kind, for it is a question that concerns the analytical chemist only. The remaining sections of the book deal with air-pumps, condensers and circulating pumps, feed heating, feed pumps, &c., and are mainly occupied with descriptions and plans of mechanical contrivances. The illustrations have been carefully prepared, and the uses of the various appliances are discussed from a practical point of view, the author giving his readers the full benefit of the experience he has acquired, besides drawing on many other authorities.

---

*Die Elektrolyse Geschmolzener Salze. Dritter Teil: Elektromotorische Kräfte.* ("The Electrolysis of Fused Salts. Part III.: Electromotive Forces"). By Richard Lorenz. Halle-a-S.: Wilhelm Knapp. 1906.

The third part of this monograph deals with electromotive forces, and is no less valuable and complete than the two preceding volumes. Dr. Lorenz has collected his material with great care, and has enriched the book with useful practical suggestions for improving known processes or evolving fresh ones. Each section contains an historical introduction which gives in all cases an interesting and unbiassed account of the work of various investigators; the theory of the special branch treated in the section is then discussed, and researches on it are described. At the end of the book a section is devoted to the application of the theory of electrolytic dissociation to the fused and solid states, and after examining the support given to the theory by observations and facts, the author unhesitatingly declares for the existence of ions in the fused state. The production of this book undoubtedly marks a decided advance in our knowledge of the electrolysis of fused salts.

# CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxlii., No. 26, June 25, 1906.

**Formation of Endothermic Combinations at High Temperatures.**—M. Berthelot.—Hitherto no exact observations have been made to establish, either in fact or in principle, that very high temperatures are susceptible of causing a reversibility of chemical affinity by provoking the direct formation of endothermic combinations by simple heating, *i.e.*, without simultaneous employment of electrical or chemical energies.

**Action of Water Vapour on Sulphides at a Red Heat. Production of Native Metals. Application to Volcanic Phenomena.**—Armand Gautier.—The water vapour which is emitted at a red heat from deep crystalline rocks, such as granite, &c., on being liberated attacks the metallic portions of these rocks (especially their ferrous silicates), peroxidising these compounds and liberating the hydrogen, accompanied by other gases (carbonic oxide, carbonic acid, methane, nitrogen, &c.). This oxidation of the silicates and of carbonic oxide by water vapour leads the author to make a complete investigation of the action of water vapour at a red heat—(1) On iron sulphides; (2) on metallic sulphides which are not decomposed by water; (3) on sulphuretted hydrogen.

**Condensation of ββ-Dimethylglycidic Ether with Sodium Malonic Ether. Synthesis of Terebic and Pyroterebic Acids.**—A. Haller and G. Blanc.—In order to prepare the cyano-ether, $[CH_3]_2=C-CHOH.CO_2C_2H_5$ / $CH<^{CN}_{CO_2C_2H_5}$, the authors condense dimethylglycidic ether with sodium cyanacetic ether. The reaction is complete after several hours' heating on a water-bath. The results were not good, better ones being obtained by using malonic ether. After various processes, 4-methyl-2 . 3-dicarboxethyl pentanolide-4 is formed as the final product, and on boiling with hydrochloric acid this ether lactone gives quantitatively an acid scarcely soluble in water and melting at 175°, corresponding to the formula $C_7H_{10}O_4$, and known as terebic acid. From this its isomer, pyroterebic acid, can be prepared by the action of heat.

**Heat of Formation of Carbonylferrohydrocyanic Acid.**—J. A. Muller.—The heat of formation of carbonylferrohydrocyanic acid from its elements can only be deduced from its heat of combustion, because the method of synthesis from ferrocyanides does not lend itself to any other method. The author finds the number 3444 cals. as a mean of seven experiments.

**Cathodic Phosphorescence of Europium Diluted with Lime. Examination of the Triple Phosphorescent System, Lime—Gadolinia—Europia.**—G. Urbain.—Whilst investigating the phosphorescence of successive fractions of europi-ferrous earths diluted with lime, the author observed a new phenomenon, which he is able to reproduce synthetically, and which shows how the radiation emitted in phosphorescence is susceptible of being modified under the influence of relatively weak chemical action. The spectrum lines are described, and the system lime—gadolinia—europia examined.

**Variations in State shown by Amorphous Carbon under the Influence of a Rapid Variation of Temperature.**—O. Manville.—The author's experiments show that the state of amorphous carbon varies sensibly with the temperature. For the same temperature, $t$, comprised between the limits $T_0$ and $T_1$ the state of the carbon is not the same when $t$ is proportional to the phase of heating or to the phase of cooling. Finally, there exists a tempera-

ture, $t$, in the heating phase, and a temperature, $t'$, different from $t$, in the cooling phase for which the state of the carbon gives with the same current of oxygen the same reaction velocity.

**Double Sulphate of Iridium and Potassium.**—Marcel Delépine.—The author investigates the complex character of the double sulphate of iridium and potassium, $Ir_2(SO_4)_3+3K_2SO_4$.

**Silicones.**—M. Boudouard.—The silicones are the products obtained by the action of hydrochloric acid on certain metallic silicides, and they have the property of being slowly decomposed by the action of water, with evolution of hydrogen. These substances represent examples of substances comparable with the triple derivatives of carbon with total substitution of silicon for the carbon. Those prepared by the author can be considered as mixtures of siliciformic anhydride and silicoxalic hydrate in varying proportions. Perfectly definite compounds cannot be prepared, on account of the difficulty of attacking the silicides and of the prolonged contact of the silicone, acid, and water which is the immediate consequence of it.

**Crystallography of Iron.**—F. Osmond and G. Cartaud.—The authors continue their researches on the crystalline forms obtained when ferrous chloride is reduced at different temperatures by hydrogen or zinc vapour. The distinctive crystalline characteristics of the three varieties of iron so prepared are given in a table..

**Action of Oxygen on Rubidium-ammonium.**—E. Rengade.—The author investigates the action of oxygen on rubidium-ammonium, and finds that the three metals potassium, cæsium, and rubidium, when dissolved in excess of liquefied ammonia, give, in presence of oxygen, first a white binoxide, and finally a yellow tetroxide. The potassium and the cæsium give, besides, a very dark trioxide, which is not found with rubidium. These oxides in order to be pure should be formed very rapidly; a slow oxidation gives a binoxide mixed with hydride and amide, and consequently superior oxides mixed with the products of oxidation of the amide, *i.e.*, nitrite and nitrate.

**Pyrazolones. New Methods of Synthesis.**—Ch. Moureu and I. Lazennec.—The authors find a new method of synthesis of pyrazolones by making the hydrazines act on the β-oxyalcoyl-acrylic ethers.

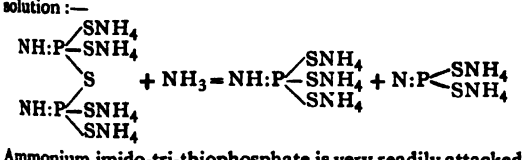
**Phenylic Migrations in Halohydrines and α-Glycols.**—M. Tiffeneau.

**Cinnamenylparaconic Acid.**—J. Bougault.

— —

*Berichte der Deutschen Chemischen Gesellschaft.*
Vol. xxxix., No. 9, 1906.

**Reaction between Phosphorus Pentasulphide and Ammonia.**—Alfred Stock.—If gaseous ammonia is led over phosphorus pentasulphide at a low temperature a yellow substance, $P_2S_5.6NH_3$, is formed. This substance, which can also be made by dissolving the sulphide in liquid ammonia and evaporating off the excess of ammonia, gradually loses its colour when an ammoniacal solution is allowed to stand for some time, leaving on evaporation $P_2S_5.7NH_3$. This latter is a mixture of two ammonium salts, from which triammonium-imido-trithiophosphate separates out in crystals after about a day, while diammonium nitrilo dithiophosphate remains in solution:—



Ammonium imido-tri-thiophosphate is very readily attacked by water, and from it a series of new products can be obtained.

**Simple and Sensitive Thermometer for Low Temperatures.**—Alfred Stock and Carl Nielsen.—In this thermometer the tension which a small quantity of liquid oxygen possesses at the temperature to be measured is determined. The thermometer consists essentially of an oxygen holder of about 25 c.c. capacity, connected with a mercury manometer. The tension of liquid oxygen at various temperatures is known fairly accurately, and the tensions at the lowest temperatures may be obtained from a tension curve. Temperatures of from $-183°$ to $-200°$ can be quickly and accurately determined with this instrument, and differences of $\frac{1}{100}°$ can be detected, while other gases can be used instead of oxygen for different ranges of temperature.

**Employment of Sodium Hydrosulphite in Gas Analysis.**—Hartwig Franzen.—The author has investigated the use of sodium hydrosulphite for the absorption of oxygen in gas analysis, and has found that its use presents many advantages. The solution is prepared by dissolving 50 grms. of the salt in 250 c.c. of water and adding 40 c.c. of caustic soda solution (500 grms. sodium hydroxide in 700 c.c. of water). According to the equation $Na_2S_2O_4+H_2O+O=2NaHSO_3$ 1 grm. of the salt absorbs 64 c.c. of oxygen. Therefore 1 c.c. of the above solution absorbs 10·7 c.c. of oxygen. It is much cheaper than pyrogallol, and the absorption proceeds as rapidly at low as at higher temperatures. It can be used to analyse gases containing the oxides of carbon, and many substances which hinder an oxidation of phosphorus have no effect on sodium hydrosulphite.

## MISCELLANEOUS.

**Institute of Chemistry of Great Britain and Ireland.**—*Pass List of the July Examinations.*—Of fourteen candidates who entered for the Intermediate Examination, the following nine passed: L. C. W. Bonacina; W. R. S. Ladell; D. J. Law; W. M. Seaber, B.Sc. (Lond.); P. Stutfield; J. M. Weir, M.A., B.Sc. (St. Andrews); W. A. Whatmough; J. M. Wilkie, B.Sc. (Lond.); and C. H. Wright, B.A. (Cantab). In the Final Examination for the Associateship (A.I.C.), of three examined in the branch of Mineral Chemistry, two passed: J. W. Agnew and I. M. Heilbron. Of three in the branch of Organic Chemistry, two passed: R. Le Rossignol, B.Sc. (Lond.), and G. W. Monier-Williams, M.A. (Oxon.), Ph.D (Freiburg). Of eight who entered in the branch of the Analysis of Food and Drugs, and of Water, including an Examination in Therapeutics, Pharmacology, and Microscopy, the following six passed: J. G. Annan, B.Sc. (Lond.); C. T. Bennett, B.Sc. (Lond.); G. W. Glen; F. W. Harris; E. H. Merritt, B.Sc. (Lond.); and F. Tattersfield. The Examiners in Chemistry were Mr. W. W. Fisher, M.A. (Oxon.), F.I.C., and Dr. G. G. Henderson, M.A. (Glasgow), F.I.C. The Examination in Therapeutics, Pharmacology, and Microscopy was conducted by Dr. F. Gowland Hopkins, M.A. (Cantab), F.R.S., F.I.C.

## NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertisement columns.

**Heat of Combustion of Iron Sulphide.**—Will some correspondent favour me with a reply to the following question:—What is the heat of combustion of iron sulphide, $FeS_2$?—A. W.

**Uranium.**—We wish to obtain some particulars concerning uranium salts:—(1) As to its character, composition, and properties; (2) approximate present market value per lb., or per ton; (3) statistics as to the quantities at present available in the different markets. If any correspondents are able to furnish us with any information concerning the above, we should be extremely grateful.—A. B. & Co.

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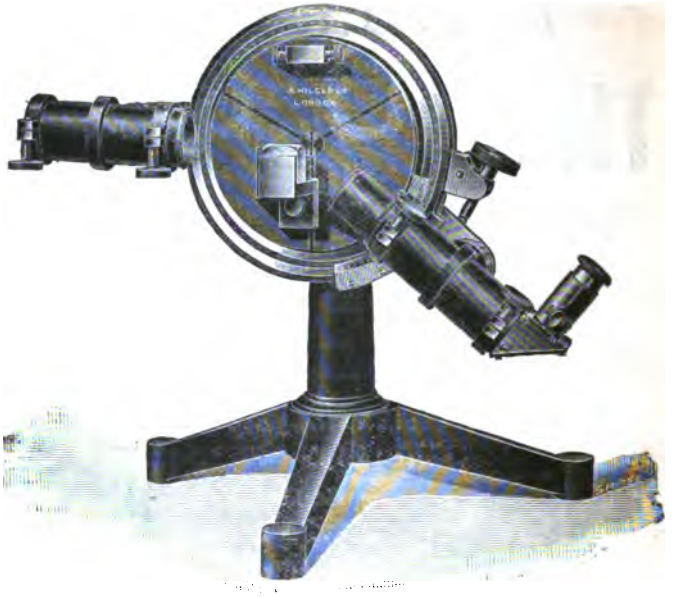

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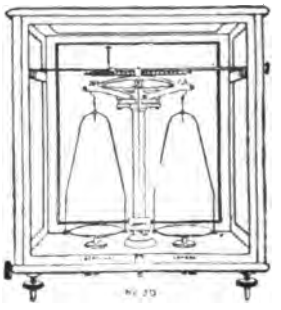

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THE CHEMICAL NEWS.

Vol. XCIV., No. 2436.

# BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

York, 1906.

## INAUGURAL ADDRESS OF THE PRESIDENT,

Prof. E. Ray Lankester, M.A., LL.D., D.Sc., F.R.S., F.L.S., Director of the Natural History Departments of the British Museum.

My Lords, Ladies, and Gentlemen,—It is, first of all, my privilege to thank you for the distinguished honour you have done me in electing me President of this great scientific Association—an honour which is enhanced by the fact that our meeting this year is once more held in the venerable city of York, in which seventy-five years ago the British Association for the Advancement of Science held its first meeting.

It is a great pleasure to me to convey to the Lord Mayor and the dignitaries and citizens of York your hearty thanks for the invitation to meet this year in their city. It seems to have become a custom that the Association should be invited at regular intervals to assemble in the city where it took birth, and to note the progress made in the objects for the furtherance of which it was founded. A quarter of a century ago we met here under the presidency of that versatile leader in public affairs—Sir John Lubbock, now Lord Avebury. That occasion was the jubilee—the fiftieth anniversary—of the Association.

Lord Avebury on that occasion gave as his presidential address a survey of the progress of science during the fifty years of the Association's existence. He had a wonderful story to tell, and told it with a fulness which was only possible to one of his wide range of knowledge and keen interest in the various branches of science. If I venture on the present occasion to say a few words as to the great features in the progress of our knowledge of Nature during the last twenty-five years, it will be readily understood that the mere volume of new knowledge to be surveyed has become so vast that a full and detailed statement such as that which Lord Avebury placed before the Association at its jubilee is no longer possible in a single address delivered from the President's chair.

Let me ask you before we go further to take for a few moments a more personal retrospect, and to think of the founders of this Association, then of the great workers in science who were still alive in 1881 when last we met here, and have since gone from among us, leaving their great deeds and their noble enthusiasm to inspire now and for all future time those who have vowed themselves to the advancement of science in this realm of Britain.

There must be some here who had the privilege of personal acquaintance with several of the men who founded this Association in York seventy-five years ago. I myself knew Professor John Phillips, Sir Charles Lyell, Sir Roderick Murchison, Sir David Brewster, Dr. Whewell, and Mr. Harcourt, of Nuneham. All these fathers of our Association had passed away before our last meeting in York. And now, in the quarter of a century which has rolled by and brought us here again, we have lost many who took an active part in its annual meetings, and were familiar figures in the scientific world of the later Victorian period. Huxley and Tyndall, Spottiswoode and Cayley, Owen and Flower, Williamson and Frankland, Falconer and Busk, Prestwich and Godwin Austen, Rolleston and Henry Smith, Stokes and Tait, and many others are in that list, including one whose name was, and is, more often heard in our discussions than any other, though he himself never was able to join us—I mean Charles Darwin. Happily some of the scientific veterans of the nineteenth century are still living, if not with us in York. Sir Joseph Hooker, who visited the Antarctic with Ross in 1839, is still hale and hearty, and so are Alfred Russel Wallace, Lord Kelvin, Sir William Huggins, and many others who were already veteran leaders in scientific investigation when last we visited York; they are still active in thought, observation, and experiment.

In attempting to give an outline of the advancement of science in the past twenty-five years I think it is necessary to distinguish two main kinds of advancement, both of which our founders had in view. Francis Bacon gave the title "Advancement of Learning" to that book in which he explained not merely the methods by which the increase of knowledge was possible, but advocated the promotion of knowledge to a new and influential position in the organisation of human society. His purpose, says Dean Church, was "to make knowledge really and intelligently the interest, not of the school or the study or the laboratory only, but of society at large." This is what our founders also intended by their use of the word "advancement." So that in surveying the advancement of science in the past quarter of a century we of the British Association must ask not only what are the new facts discovered, the new ideas and conceptions which have come into activity, but what progress has science made in becoming really and intelligently the interest of society at large. Is there evidence that there is an increase in the influence of science on the lives of our fellow-citizens and in the great affairs of the State? Is there an increased provision for securing the progress of scientific investigation in proportion to the urgency of its need or an increased disposition to secure the employment of really competent men trained in scientific investigation for the public service?

### I. *The Increase of Knowledge in the Several Branches of Science.*

The boundaries of my own understanding and the practical consideration of what is appropriate to a brief address must limit my attempt to give to the general public who follow with friendly interest our proceedings some presentation of what has been going on in the workshops of science in this last quarter of a century. My point of view is essentially that of the naturalist, and in my endeavour to speak of some of the new things and new properties of things discovered in recent years I find it is impossible to give any systematic or detailed account of what has been done in each division of science. All that I can attempt is to mention some of the discoveries which have aroused my own interest and admiration. I feel, indeed, that it is necessary to ask your forbearance for my presumption in daring to speak of so many subjects in which I cannot claim to speak as an authority, but only as a younger brother full of fraternal pride and sympathy in the glorious achievements of the great experimentalists and discoverers of our day. The duty of attempting some indication of their work is placed upon me as your President, and it is for my effort to discharge that duty that I ask your generous consideration.

As one might expect, the progress of the knowledge of nature (for it is to that rather than to the historical, moral, and mental sciences that English-speaking people refer when they use the word "science") has consisted, in the last twenty-five years, in the amplification and fuller verification of principles and theories already accepted, and in the discovery of hitherto unknown things which either have fallen into place in the existing scheme of each science or have necessitated new views, some not very disturbing to existing general conceptions, others of a more startling and, at first sight, disconcerting character. Nevertheless, I think I am justified in saying that, exciting and of entrancing interest as have been some of the discoveries of the past few years, there has been nothing to lead us to conclude that we have been on the wrong path—nothing

which is really revolutionary; that is to say, nothing which cannot be accepted by an intelligible modification of previous conceptions. There is, in fact, continuity and healthy evolution in the realm of science. Whilst some onlookers have declared to the public that science is at an end, its possibilities exhausted, and but little of the hopes it raised realised, others have asserted, on the contrary, that the new discoveries—such as those relating to the X-rays and to radium—are so inconsistent with previous knowledge as to shake the foundations of science, and to justify a belief in any and every absurdity of an unrestrained fancy. These two reciprocally destructive accusations are due to a class of persons who must be described as the enemies of science. Whether their attitude is due to ignorance or traditions of self-interest, such persons exist; and it is one of the objects of this Association to combat their assertions and to demonstrate, by the discoveries announced at its meetings and the consequent orderly building up of the great fabric of "natural knowledge," that Science has not come to the end of her work—has, indeed, only as yet given mankind a foretaste of what she has in store for it—that her methods and her accomplished results are sound and trustworthy, serving with perfect adaptability for the increase of true discovery, and the expansion and development of those general conceptions of the processes of nature at which she aims.

*New Chemical Elements.*—There can be no doubt that the past quarter of a century will stand out for ever in human history as that in which new chemical elements, not of an ordinary type, but possessed of truly astounding properties, were made known with extraordinary rapidity and sureness of demonstration. Interesting as the others are, it is the discovery of radio-activity and of the element radium which so far exceeds all others in importance that we may well account it a supreme privilege that it has fallen to our lot to live in the days of this discovery. No single discovery ever made by the searchers of nature even approaches that of radio-activity in respect of the novelty of the properties of matter suddenly revealed by it. A new conception of the structure of matter is necessitated and demonstrated by it, and yet, so far from being destructive and disconcerting, the new conception fits in with, grows out of, and justifies the older schemes which our previous knowledge has formulated.

Before saying more of radio-activity, which is apt to eclipse in interest every other topic of discourse, I must recall to you the discovery of the five inert gaseous elements by Rayleigh and Ramsay, which belongs to the period on which we are looking back. It was found that nitrogen obtained from the atmosphere invariably differed in weight from nitrogen obtained from one of its chemical combinations; and thus the conclusion was arrived at by Rayleigh that a distinct gas is present in the atmosphere, to the extent of 1 per cent, which had hitherto passed for nitrogen. This gas was separated, and to it the name argon (the lazy one) was given, on account of its incapacity to combine with any other element. Subsequently, this argon was found by Ramsay to be itself impure, and from it he obtained three other gaseous elements equally inert: namely, neon, krypton, and xenon. These were all distinguished from one another by the spectrum, the sign-manual of an element given by the light emitted in each case by the gas when in an incandescent condition. A fifth inert gaseous element was discovered by Ramsay as a constituent of certain minerals which was proved by its spectrum to be identical with an element discovered twenty-five years ago by Sir Norman Lockyer in the atmosphere of the sun, where it exists in enormous quantities. Lockyer had given the name (helium) to this new solar element, and Ramsay thus found it locked up in certain rare minerals in the crust of the earth.

But by helium we are led back to radium, for it has been found only two years ago by Ramsay and Soddy that helium is actually formed by a gaseous emanation from radium. Astounding as the statement seems, yet that is one of the many unprecedented facts which recent study has brought to light. The alchemist's dream is, if not realised, at any rate justified. One element is actually under our eyes converted into another; the element radium decays into a gas which changes into another element, namely, helium.

Radium, this wonder of wonders, was discovered owing to the study of the remarkable phosphorescence, as it is called—the glowing without heat—of glass vacuum-tubes through which electric currents are made to pass. Crookes, Lenard, and Röntgen each played an important part in this study, showing that peculiar rays or linear streams of at least three distinct kinds are set up in such tubes—rays which are themselves invisible, but have the property of making glass or other bodies which they strike glow with phosphorescent light. The celebrated Röntgen rays make ordinary glass give out a bright green light; but they pass through it, and cause phosphorescence outside in various substances, such as barium platino-cyanide, calcium tungstate, and many other such salts; they also act on a photographic plate and discharge an electrified body such as an electroscope. But the most remarkable feature about them is their power of penetrating substances opaque to ordinary light. They will pass through thin metal plates or black paper or wood, but are stopped by more or less dense material. Hence it has been possible to obtain "shadow pictures" or skiagraphs by allowing the invisible Röntgen rays to pass through a limb or even a whole animal, the denser bone stopping the rays, whilst the skin, flesh, and blood let them through. They are allowed to fall (still invisible) on to a photographic plate, when a picture like an ordinary permanent photograph is obtained by their chemical action, or they may be made to exert their phosphorescence-producing power on a glass plate covered with a thin coating of a phosphorescent salt such as barium platino-cyanide, when a temporary picture in light and shade is seen.

The rays discovered by Röntgen were known as the X-rays, because their exact nature was unknown. Other rays studied in the electrified vacuum-tubes are known as cathode rays, or radiant corpuscles, and, others, again, as the Lenard rays.

It occurred to M. Henri Becquerel, as he himself tells us, to inquire whether other phosphorescent bodies besides the glowing vacuum-tubes of the electrician's laboratory can emit penetrating rays like the X-rays. I say "other phosphorescent bodies," for this power of glowing without heat—of giving out, so to speak, cold light—is known to be possessed by many mineral substances. It has become familiar to the public in the form of "phosphorescent paint," which contains sulphide of calcium, a substance which shines in the dark after exposure to sunlight—that is to say, is phosphorescent. Other sulphides and the minerals fluor-spar, apatite, some gems, and, in fact, a whole list of substances have, under different conditions of treatment, this power of phosphorescence or shining in the dark without combustion or chemical change. All, however, require some special treatment, such as exposure to sunlight or heat or pressure, to elicit the phosphorescence, which is of short duration only. Many of the compounds of a somewhat uncommon metallic element, called uranium, used for giving a fine green colour to glass, are phosphorescent substances, and it was, fortunately, one of them which Henri Becquerel chose for experiment. Henri Becquerel is professor in the Jardin des Plantes of Paris; his laboratory is a delightful old-fashioned building, which had for me a special interest and sanctity when, a few years ago, I visited him there, for, a hundred years before, it was the dwelling-house of the great Cuvier. Here Henri Becquerel's father and grandfather—men renowned throughout the world for their discoveries in mineralogy, electricity, and light—had worked, and here he had himself gone almost daily from his earliest childhood. Many an experiment bringing new knowledge on the relations of light and electricity had Henri Becquerel carried out in that quiet old-world place before the day on

which, about twelve years ago, he made the experimental inquiry, Does uranium give off penetrating rays like Röntgen's rays? He wrapped a photographic plate in black paper, and on it placed and left lying there for twenty-four hours some uranium salt. He had placed a cross, cut out in thin metallic copper, under the uranium powder, so as to give some shape to the photographic print should one be produced. It *was* produced. Penetrating rays were given off by the uranium: the black paper was penetrated, and the form of the copper cross was printed on a dark ground. The copper was also penetrated to some extent by the rays from the uranium, so that its image was not left actually white. Only one step more remained before Becquerel made his great discovery. It was known, as I stated just now, that sulphide of calcium and similar substances *become* phosphorescent when exposed to sunlight, and lose this phosphorescence after a few hours. Becquerel thought at first that perhaps the uranium acquired its power similarly by exposure to light; but very soon, by experimenting with uranium long kept in the dark, he found that the emission of penetrating rays, giving photographic effects, was produced spontaneously. The emission of rays by this particular fragment of uranium has shown no sign of diminution since this discovery. The emission of penetrating rays by uranium was soon found to be independent of its phosphorescence. Phosphorescent bodies, as such, do not emit penetrating rays. Uranium compounds, whether phosphorescent or not, emit, and continue to emit, these penetrating rays, capable of passing through black paper and metallic copper. They do not derive this property from the action of light or any other treatment. The emission of these rays discovered by Becquerel is a new property of matter. It is called "radio-activity," and the rays are called Becquerel rays.

From this discovery by Becquerel to the detection and separation of the new element radium is an easy step in thought, though one of enormous labour and difficulty in practice. Professor Pierre Curie (whose name I cannot mention without expressing the grief with which we all heard in last April of the sad accident by which his life was taken) and his wife, Madame Sklodowska Curie, incited by Becquerel's discovery, examined the ore called pitchblende which is worked in mines in Bohemia and is found also in Cornwall. It is the ore from which all commercial uranium is extracted. The Curies found that pitchblende has a radio-activity four times more powerful than that of metallic uranium itself. They at once conceived the idea that the radio-activity of the uranium salts examined by Becquerel is due not to the uranium itself, but to another element present with it in variable quantities. This proved to be in part true. The refuse of the first processes by which in the manufacturer's works the uranium is extracted from its ore, pitchblende, was found to contain four times more of the radio-active matter than does the pure uranium. By a long series of fusions, solutions, and crystallisations the Curies succeeded in "hunting down," as it were, the radio-active element. The first step gave them a powder mixed with barium chloride, and having 2000 times the activity of the uranium in which Becquerel first proved the existence of the new property—radio-activity. Then step by step they purified it to a condition 10,000 times, then to 100,000 times, and, finally, to the condition of a crystalline salt having 1,800,000 times the activity of Becquerel's sample of uranium. The purification could go no further, but the extraordinary minuteness of the quantity of the pure radio-active substance obtained, and the amount of labour and time expended in preparing it, may be judged of from the fact that of one ton of the pitchblende ore submitted to the process of purification only the hundredth of a grm.—the one-seventh of a grain—remained.

The amount of radium in pitchblende is one ten-millionth per cent; rarer than gold in sea-water. The marvel of this story and of all that follows consists largely in the skill and accuracy with which our chemists and physicists have learnt to deal with such infinitesimal quantities, and the gigantic theoretical results which are securely posed on this pin-point of substantial matter.

The Curies at once determined that the minute quantity of colourless crystals they had obtained was the chloride of a new metallic element with the atomic weight 225, to which they gave the name radium. The proof that radium is an element is given by its "sign-manual"—the spectrum which it shows to the observer when in the incandescent state. It consists of six bright lines and three fainter lines in the visible part of the spectrum, and of three very intense lines in the ultra-violet (invisible) part. A very minute quantity is enough for this observation; the lines given by radium are caused by no other known element in heaven or earth. They prove its title to be entered on the roll-call of elements.

The atomic weight was determined in the usual way by precipitating the chlorine in a solution of radium chloride by means of silver. None of the precious element was lost in the process, but the Curies never had enough of it to venture on any attempt to prepare pure metallic radium. This is a piece of extravagance no one has yet dared to undertake. Altogether, the Curies did not have more than some four or five grains of chloride of radium to experiment with, and the total amount prepared and now in the hands of scientific men in various parts of the world probably does not amount to more than sixty grains at most. When Professor Curie lectured on radium four years ago at the Royal Institution in London he made use of a small tube an inch long and of one-eighth bore, containing nearly the whole of his precious store, wrenched by such determined labour and consummate skill from tons of black shapeless pitchblende. On his return to Paris he was one day demonstrating in his lecture-room with this precious tube the properties of radium, when it slipped from his hand, broke, and scattered far and wide the most precious and magical powder ever dreamed of by alchemist or artist of romance. Every scrap of dust was immediately and carefully collected, dissolved, and re-crystallised, and the disaster averted with a loss of but a minute fraction of the invaluable product.

Thus, then, we have arrived at the discovery of radium—the new element endowed in an intense form with the new property "radio-activity" discovered by Becquerel. The wonder of this powder, incessantly and without loss, under any and all conditions pouring fourth by virtue of its own intrinsic property powerful rays capable of penetrating opaque bodies, and of exciting phosphorescence and acting on photographic plates, can perhaps be realised when we reflect that it is as marvellous as though we should dig up a stone which without external influence or change, continually poured forth light or heat, manufacturing both in itself, and not only continuing to do so without appreciable loss or change, but necessarily having always done so for countless ages whilst sunk beyond the ken of man in the bowels of the earth.

Wonderful as the story is, so far it is really simple and commonplace compared with what yet remains to be told. I will only barely and abruptly state the fact that radio-activity has been discovered in other elements, some very rare, such as actinium and polonium; others more abundant and already known, such as thorium and uranium, though their radio-activity was not known until Becquerel's pioneer-discovery. It is a little strange and no doubt significant that, after all, pure uranium is found to have a radio-activity of its own, and not to have been altogether usurping the rights of its infinitesimal associate.

The wonders connected with radium really begin when the experimental examination of the properties of a few grains is made. What I am saying here is not a systematic technical account of radium; so I shall venture to relate some of the story as it impresses me.

Leaving aside for a moment what has been done in regard to the more precise examination of the rays emitted by radium, the following astonishing facts have been found out in regard to it:—1. If a glass tube containing radium is much handled or kept in the waistcoat pocket, it pro-

duces a destruction of the skin and flesh over a small area —in fact, a sore place. 2. The smallest trace of radium brought into a room where a charged electroscope is present, causes the discharge of the electroscope. So powerful is this electrical action of radium that a very sensitive electrometer can detect the presence of a quantity of radium five hundred thousand times more minute than that which can be detected by the spectroscope (that is to say, by the spectroscopic examination of a flame in which minute traces of radium are present). 3. Radium actually realises one of the properties of the hypothetical stone to which I compared it giving out light and heat. For it does give out heat which it makes itself incessantly and without appreciable loss of substance or energy ("appreciable" is here an important qualifying term). It is also faintly self-luminous. Fairly sensitive theromometers show that a few granules of radium salt have always a higher temperature than that of surrounding bodies. Radium has been proved to give out enough heat to melt rather more than its own weight of ice every hour; enough heat in one hour to raise its own weight of water from the freezing-point to the boiling-point. After a year and six weeks a gramme of radium has emitted enough heat to raise the temperature of a thousand kilogrms. of water one degree. And this is always going on. Even a small quantity of radium diffused through the earth will suffice to keep up its temperature against all loss by radiation! If the sun consists of a fraction of 1 per cent of radium this will account for and make good the heat that is annually lost by it.

This is a tremendous fact, upsetting all the calculations of physicists as to the duration in past and future of the sun's heat and the temperature of the earth's surface. The geologists and the biologists have long contended that some thousand million years must have passed during which the earth's surface has presented approximately the same conditions of temperature as at present, in order to allow time for the evolution of living things and the formation of the aqueous deposits of the earth's crust. The physicists, notably Professor Tait and Lord Kelvin, refused to allow more than ten million years (which they subsequently increased to a hundred million)—basing this estimate on the rate of cooling of a sphere of the size and composition of the earth. They have assumed that its material is self-cooling. But, as Huxley pointed out, mathematics will not give a true result when applied to erroneous data. It has now, within these last five years, become evident that the earth's material is *not* self-cooling, but, on the contrary, self heating. And away go the restrictions imposed by physicists on geological time. They now are willing to give us not merely a thousand million years, but as many more as we want.

And now I have to mention the strangest of all the proceedings of radium—a proceeding in which the other radio-active bodies, actinium and thorium, resemble it. This proceeding has been entirely Rutherford's discovery in Canada, and his name must be always associated with it. Radium (he discovered) is continually giving off, apart from and in addition to the rectilinear darting rays of Becquerel—an "emanation"—a gaseous "emanation." This "emanation" is radio-active—that is, gives off Becquerel rays—and deposits "something" upon bodies brought near the radium, so that they become radio-active, and remain so for a time after the radium is itself removed. This emanation is always being formed by a radium salt, and may be most easily collected by dissolving the salt in water, when it comes away with a rush, as a gas. Sixty milligrms. of bromide of radium yielded to Ramsay and Soddy 0·124 (or about $\frac{1}{8}$) of a cubic millimetre of this gaseous emanation. What is it? It cannot be destroyed or altered by heat or by chemical agents; it is a heavy gas, having a molecular density of 100, and it can be condensed to a liquid by exposing it to the great cold of liquid air. It gives a peculiar spectrum of its own, and is probably a hitherto unknown inert gas—a new element similar to argon. But this by no means completes its history, even so far as experiments have as yet gone. The radium emanation decays, changes its character altogether, and loses half its radio-activity every four days. Precisely at the same rate as it decays the specimen of radium salt from which it was removed forms a new quantity of emanation, having just the amount of radio-activity which has been lost by the old emanation. All is not known about the decay of the emanation, but one thing is absolutely certain, having first been discovered by Ramsay and Soddy and subsequently confirmed by independent experiment by Madame Curie. It is this: After being kept three or four days the emanation becomes, in part at least, converted into helium—the light gas (second only in the list of elements to hydrogen), the gas found twenty-five years ago by Lockyer in the sun, and since obtained in some quantities from rare radio-active minerals by Ramsay! The proof of the formation of helium from the radium emanation is, of course, obtained by the spectroscope, and its evidence is beyond assail. Here, then, is the partial conversion or decay of one element, radium, through an intermediate stage into another. And not only that, but if, as seems probable, the presence of helium indicates the previous presence of radium, we have the evidence of enormous quantities of radium in the sun, for we know helium is there in vast quantity. Not only that, but inasmuch as helium has been discovered in most hot springs and in various radio-active minerals in the earth, it may be legitimately argued that no inconsiderable quantity of radium is present in the earth. Indeed, it now seems probable that there is enough radium in the sun to keep up its continual output of heat, and enough in the earth to make good its loss of heat by radiation into space, for an almost indefinite period. Other experiments of a similar kind have rendered it practically certain that radium itself is formed by a somewhat similar transformation of uranium, so that our ideas as to the permanence and immutability on this globe of the chemical elements are destroyed, and must give place to new conceptions. It seems not improbable that the final product of the radium emanation after the helium is removed is or becomes the metal lead!

It must be obvious from all the foregoing that radium is very slowly, but none the less surely, destroying itself. There is a definite loss of particles which, in the course of time, must lead to the destruction of the radium, and it would seem that the large new credit on the bank of time given to biologists in consequence of its discovery has a definite, if remote, limit. With the quantities of radium at present available for experiment, the amount of loss of particles is so small, and the rate so slow, that it cannot be weighed by the most delicate balance. Nevertheless, it has been calculated that radium will transform half of itself in about fifteen hundred years, and unless it were being produced in some way all of the radium now in existence would disappear much too soon to make it an important geological factor in the maintenance of the earth's temperature. As a reply to this depreciatory statement we have the discovery by Rutherford and others that radium is continually being formed afresh, and from that particular element in connection with which it was discovered, namely, uranium. Hypotheses and experiments as to the details of this process are at this moment in full swing, and results of a momentous kind, involving the building-up of an element with high atomic weight by the interaction of elements with a lower atomic weight are thought by some physicists to be not improbable in the immediate future.

The delicate electric test for radio-activity has been largely applied in the last few years to all sorts and conditions of matter. As a result it appears that the radium emanation is always present in our atmosphere; that the air in caves is especially rich in it, as are underground waters. Tin-foil, glass, silver, zinc, lead, copper, platinum, and aluminium are, all of them, slightly radio-active. The question has been raised whether this widespread radio-activity is due to the wide dissemination of infinitesimal quantities of strong radio-active elements, or whether it is the natural intrinsic property of all matter to emit Becquerel rays. This is the immediate subject of research.

Over and above the more simply appreciable facts which I have thus narrated, there comes the necessary and difficult enquiry—What does it all mean? What *are* the Becquerel rays of radio-activity? What must we conceive to be the structure and mechanism of the atoms of radium and allied elements, which can not only pour forth ceaseless streams of intrinsic energy from their own isolated substance, but are perpetually, though in infinitesimal proportions, changing their elemental nature spontaneously, so as to give rise to other atoms which we recognise as other elements?

I cannot venture as an expositor into this field. It belongs to that wonderful group of men, the modern physicists, who with an almost weird power of visual imagination combine the great instrument of exact statement and mental manipulation called mathematics, and possess an ingenuity and delicacy in appropriate experiment which must fill all who even partially follow their triumphant handling of nature with reverence and admiration. Such men now or recently among us are Kelvin, Clerk Maxwell, Crookes, Rayleigh, and J. J. Thomson.

Becquerel showed early in his study of the rays emitted by radium that some of them could be bent out of their straight path by making them pass between the poles of a powerful electro-magnet. In this way have finally been distinguished three classes of rays given off by radium:—(1) the $\alpha$-rays, which are only slightly bent, and have little penetrative power; (2) the $\beta$-rays, easily bent in a direction opposite to that in which the $\alpha$-rays bend, and of considerable penetrative power; (3) the $\gamma$-rays, which are absolutely unbendable by the strongest magnetic force, and have an extraordinary penetrative power, producing a photographic effect through a foot thickness of solid iron.

The $\alpha$-rays are shown to be streams of tiny bodies positively electrified, such as are given off by gas flames and red-hot metals. The particles have about twice the mass of a hydrogen atom, and they fly off with a velocity of 20,000 miles a second; that is, 40,000 times greater than that of a rifle bullet. The heat produced by radium is ascribed to the impact of these particles of the $\alpha$-rays.

The $\beta$-rays are streams of corpuscles similar to those given off by the cathode in a vacuum tube. They are charged with negative electricity and travel at the velocity of 100,000 miles a second. They are far more minute than the $\alpha$ particles. Their mass is equal to the one-thousandth of a hydrogen atom. They produce the major part of the photographic and phosphorescent effects of the radium rays.

The $\gamma$-rays are apparently the same, or nearly the same, thing as the X-rays of Röntgen. They are probably not particles at all, but pulses or waves in the ether set up during the ejection of the corpuscles which constitute the $\beta$-rays. They produce the same effects in a much smaller degree as do the $\beta$-rays, but are more penetrating.

The kind of conceptions to which these and like discoveries have led the modern physicist in regard to the character of that supposed unbreakable body—the chemical atom—the simple and unaffected friend of our youth—are truly astounding. But I would have you notice that they are not destructive of our previous conceptions, but rather elaborations and developments of the simpler views, introducing the notion of structure and mechanism, agitated and whirling with tremendous force, into what we formerly conceived of as homogeneous or simply built-up particles, the earlier conception being not so much a positive assertion of simplicity as a non-committal expectant formula awaiting the progress of knowledge and the revelations which are now in our hands.

As I have already said, the attempt to show in detail how the marvellous properties of radium and radio-activity in general are thus capable of a pictorial or structural representation is beyond the limits both of my powers and the time allowed me; but the fact that such speculations furnish a scheme into which the observed phenomena can be fitted is what we may take on the authority of the physicists and chemists of our day.

Intimately connected with all the work which has been done in the past twenty-five years in the nature and possible transformations of atoms is the great series of investigations and speculations on astral chemistry and the development of the chemical elements which we owe to the unremitting labour during this period of Sir Norman Lockyer.

*Wireless Telegraphy.*—Of great importance has been the whole progress in the theory and practical handling of electrical phenomena of late years. The discovery of the Hertzian waves and their application to wireless telegraphy is a feature of this period, though I may remind some of those who have been impressed by these discoveries that the mere fact of electrical action at a distance is that which hundreds of years ago gave to electricity its name. The power which we have gained of making an instrument oscillate in accordance with a predetermined code of signalling, although detached and a thousand miles distant, does not really lend any new support to the notion that the old-time beliefs of thought-transference and second sight are more than illusions based on incomplete observation and imperfect reasoning. For the important factors in such human intercourse—namely, a signalling-instrument and a code of signals—have not been discovered, as yet, in the structure of the human body, and have to be consciously devised and manufactured by man in the only examples of thought-transference over long distances at present discovered or laid bare to experiment and observation.

*High and low Temperatures.*—The past quarter of a century has witnessed a great development and application of the methods of producing both very low and very high temperatures. Sir James Dewar, by improved apparatus, has produced liquid hydrogen and a fall of temperature probably reaching to the absolute zero. A number of applications of extremely low temperatures to research in various directions has been rendered possible by the facility with which they may now be produced. Similarly high temperatures have been employed in continuation of the earlier work of Deville, and others by Moissan, the distinguished French chemist.

*Progress in Chemistry.*—In chemistry generally the theoretical tendency guiding a great deal of work has been the completion and verification of the "periodic law" of Mendeléeff; and on the other hand, the search by physical agents such as light and electricity for evidence as to the arrangement of atoms in the molecules of the most diverse chemical compounds. The study of "valency" and its outcome, stereo-chemistry, have been the special lines in which chemistry has advanced. As a matter of course hundreds, if not thousands, of new chemical bodies have been produced in the laboratory of greater or less theoretical interest. The discovery of the greatest practical and industrial importance in this connection is the production of indigo by synthetical processes, first by laboratory and then by factory methods, so as to compete successfully with the natural product. Von Baeyer and Heumann are the names associated with this remarkable achievement, which has necessarily dislocated a large industry which derived its raw material from British India.

(Note.—I had at first intended to give in this address a more detailed and technical statement of the progress of science than I have found possible when actually engaged in its preparation. The limits of time and space render any such survey on this occasion impossible, and moreover, the patience of even the general meeting of the British Association cannot be considered as unlimited. With a view to to the preparation of a more detailed review, I had asked a number of friends and colleagues to send me notes on the progress and tendency in their own particular branches of science. They responded with the greatest generosity and unselfishness. I must entirely disclaim for them any responsibility for the brief detached statements made in the address. At the same time I should wish to thank them here by name for their most kind and timely help. They are Sir William Ramsay, Professor Soddy, Professor H. H. Turner, Professor Marr, Professor

Haddon, Dr. Smith Woodward, Professor Sherington, Professor Farmer, Professor Vines, Mr. D. Scott, Professor Meldola, Mr. Macdougal, Professor Poulton, Mr. C. V. Boys, Colonel MacMahon, and Professor Mackinder).

*Astronomy.*—A biologist may well refuse to offer any remarks on his own authority in regard to this earliest and grandest of all the sciences. I will therefore at once say that my friend the Savilian Professor of Astronomy in Oxford has turned my thoughts in the right direction in regard to this subject. There is no doubt that there has been an immense "revival" in astronomy since 1881; it has developed in every direction. The invention of the "dry plate," which has made it possible to apply photography freely in all astronomical work, is the chief cause of its great expansion. Photography was applied to astronomical work before 1881, but only with difficulty and haltingly. It was the dry-plate which made long exposures possible, and thus enabled astronomers to obtain regular records of faintly luminous objects such as nebulæ and star-spectra. Roughly speaking, the number of stars visible to the naked eye may be stated as eight thousand: this is raised by the use of our best telescopes to a hundred million. But the number which can be photographed is indefinite and depends on length of exposure: a thousand million can certainly be so recorded.

The serious practical proposal to "chart the sky" by means of photography certainly dates from this side of 1881. The Paris Conference of 1887, which made an international scheme for sharing the sky among eighteen observatories (still busy with the work, and producing excellent results), originated with photographs of the comet of 1882, taken at the Cape Observatory.

Professor Pickering, of Harvard, did not join this co-operative scheme, but has gradually devised methods of charting the sky very rapidly, so that he has at Harvard records of the whole sky many times over, and when new objects are discovered he can trace their history *backwards* for more than a dozen years by reference to his plates. This is a wonderful new method, a mode of keeping record of present movements and changes which promises much for the future of astronomy. By the photographic method hundreds of new variable stars and other interesting objects have been discovered. New planets have been detected by the hundred. Up to 1881 two hundred and twenty were known. In 1881 only one was found; namely, Stephania, being No. 220, discovered on May 19. Now a score at least are discovered every year. Over five hundred are now known. One of these—Eros—(No. 433) is particularly interesting, since it is nearer to the sun than is Mars, and gives a splendid opportunity for fixing with increased accuracy the sun's distance from the earth. Two new satellites to Saturn and two to Jupiter have been discovered by photography (besides one to Jupiter in 1892 by the visual telescope of the Lick Observatory). One of the new satellites of Saturn goes round that planet the *wrong way*, thus calling for a fundamental revision of our ideas of the origin of the solar system.

The introduction of photography has made an immense difference in spectroscopic work. The spectra of the stars have been readily mapped out and classified, and now the motions in the line of sight of faint stars can be determined. This "motion in the line of sight," which was discernible but scarcely measurable with accuracy before, now provides one of the most refined methods in astronomy for ascertaining the dimensions and motions of the universe. It gives us velocities in miles per second instead of in an angular unit to be interpreted by a very imperfect knowledge of the star's distance. The method was in 1881 a mere curiosity, which Huggins was almost alone in having examined, though visual measures had been begun at Greenwich in 1875, and were continued for many years, only to be ultimately found to be affected by systematic error. The photographic method started by Vogel in 1887 really has made all the difference, and this work is now a vast department of astronomical industry. Among other by-products of the method are the "spectroscopic doubles," stars which we know to be double, and of which we can determine the period of revolution, though we cannot separate them visually by the greatest telescope.

Work on the sun has been entirely revolutionised by the use of photography. The last decade has seen the invention of the spectro-heliograph—which simply means that astronomers can now study *in detail* portions of the sun of which they could previously only get a bare indication.

More of the same story could be related, but enough has been said to show how full of life and progress is this most ancient and imposing of all sciences.

A minor though very important influence in the progress of astronomy has been the provision, by the expenditure of great wealth in America of great telescopes and equipments.

In 1877 my distinguished predecessor in the presidency of the British Association started a line of mathematical research which has been very fruitful and is of great future promise for astronomy. He was able himself last year to give some account of this research to the Association. On the present occasion I may mention that as recently as last April, at the Royal Astronomical Society, two important papers were read—one by Mr. Cowell and the other by Mr. Stratton—which have their roots in Sir George Darwin's work. The former was led to suggest that the day is lengthening ten times as rapidly as had been supposed, and the latter showed that in all probability the planets had all turned upside down since their birth.

And yet M. Brunettière and his friends wish us to believe that science is bankrupt and has no new things in store for humanity.

*Geology.*—In the field of geological research the main feature in the past twenty-five years has been the increasing acceptance of the evolutionary as contrasted with the uniformitarian view of geological phenomena. The great work of Suess, "Das Antlitz der Erde," is undoubtedly the most important contribution to physical geology within the period. The first volume appeared in 1885, and the impetus which it has given to the science may be judged of by the epithet applied to the views for which Suess is responsible—"the New Geology." Suess attempts to trace the orderly sequence of the principal changes in the earth's crust since it first began to form. He strongly opposes the whole theory of elevation, and accounts for the movements as due to differential collapse of the crust, accompanied by folding due to tangential stress. Among special results gained by geologists in the period we survey may be cited new views as to the origin of the crystalline schists, favouring a return to something like the hypogene origin advocated by Lyell; the facts as to deep-sea deposits, now in course of formation, embodied in the "Challenger" reports on that subject; the increasing discrimination and tracking of those minor divisions of strata called "zones"; the assignment of the Olennellus fauna of Cambrian age to a position earlier than that of the Paradoxides fauna; the discovery of Radiolaria in palæozoic rocks by special methods of examination, and the recognition of Graptolites as indices of geological horizons in lower palæozoic beds. Glacially eroded rocks in boulder-clays of permo-carboniferous age have been recognised in many parts of the world (*e.g.* Australia and South Africa), and thus the view put forward by W. T. Blanford as to the occurrence of the same phenomena in conglomerates of this age to India is confirmed. Eozoon is finally abandoned as owing its structure to an organism. The oldest fosiliferous beds known to us are still far from the beginning of life. They contain a highly developed and varied animal fauna—and something like the whole of the older moiety of rocks of aqueous origin have failed as yet to present us with any remains of the animals or plants which must have inhabited the seas which deposited them. The boring of a coral reef initiated by Professor Sollas at the Nottingham meeting of this Association in 1893 was successfully carried out, and a depth of 1114½ feet reached. Information of great value to geologists was thus obtained.

*Animal and Vegetable Morphography.*—Were I to attempt to give an account of the new kinds of animals and plants discovered since 1881, I should have to read out a bare catalogue, for time would not allow me to explain the interest attaching to each. Explorers have been busy in all parts of the world—in Central Africa, in the Antarctic, in remote parts of China, in Patagonia and Australia, and on the floor of the ocean, as well as in caverns, on mountain tops, and in great lakes and rivers. We have learnt much that is new as to distribution; countless new forms have been discovered, and careful anatomical and microscopical study conducted on specimens sent home to our laboratories. I cannot refrain from calling to mind the discovery of the eggs of the Australian duckmole and hedgehog; the fresh-water jelly-fish of Regent's Park, the African lakes, and the Delaware River; the marsupial mole of Central Australia; the okapi; the young and adult of the mud-fishes of Australia, Africa, and South America; the fishes of the Nile and Congo; the gill-bearing earth worms and mud worms; the various forms of the caterpillar-like Peripatus; strange deep-sea fishes, polyps and sponges.

The main result of a good deal of such investigation is measured by our increased knowledge of the pedigree of organisms, what used to be called "classification." The anatomical study by the Australian professors, Hill and Wilson, of the teeth and the fœtus of the Australian group of pouched mammals—the marsupials—has entirely upset previous notions, to the effect that these were a primitive group, and has shown that their possession of only one replacing tooth is a retention of one out of many such teeth (the germs of which are present), as in placental mammals; and further that many of these marsupials have the nourishing outgrowth of the fœtus called the placenta fairly well developed, so that they must be regarded as a degenerate side-branch of the placental mammals, and not as primitive forerunners of that dominant series.

Speculations as to the ancestral connection of the great group of vertebrates with other great groups have been varied and ingenious; but most naturalists are now inclined to the view that it is a mistake to assume any such connection in the case of vertebrates of a more definite character than we admit in the case of starfishes, shellfish, and insects. All these groups are ultimately connected by very simple, remote, and not by proximate ancestors, with one another and with the ancestors of vertebrates.

The origin of the limbs of vertebrates is now generally agreed to be correctly indicated in the Thatcher-Mivart-Balfour theory to the effect that they are derived from a pair of continuous lateral fins, in fish-like ancestors, similar in every way to the continuous median dorsal fin of fishes.

The discovery of the formation of true spermatozoa by simple unicellular animals of the group Protozoa is a startling thing, for it had always been supposed that these peculiar reproductive elements were only formed by multicellular organisms. They have been discovered in some of the gregarina-like animalcules, the Coccidia, and also in the blood-parasites.

Among plants, one of the most important discoveries relates to these same reproductive elements, the spermatozoa, which by botanists are called antherozoids. A great difference between the whole higher series of plants, the flowering plants or phanerogams, and the cryptogams or lower plants, including ferns, mosses, and algæ, was held to be that the latter produce vibratile spermatozoa like those of animals which swim in liquid and fertilise the motionless egg-cell of the plant. Two Japanese botanists (and the origin of this discovery from Japan, from the University of Tokio, in itself marks an era in the history of science), Hirase and Ikeno, astonished the botanical world fifteen years ago by showing that motile antherozoids or spermatozoa are produced by two gymnosperms, the ging-ko tree (or Salisburya) and the cycads. The pollen tube, which is the fertilising agent in all other phanerogams, develops in these cone-bearing trees beautiful motile spermatozoa, which swim in a cup of liquid provided for them in connection with the ovules. Thus a great distinction between phanerogams and cryptogams was broken down, and the actual nature of the pollen-tube as a potential parent of spermatozoids demonstrated.

When we come to the results of the digging out and study of extinct plants and animals, the most remarkable results of all in regard to the affinities and pedigree of organisms have been obtained. Among plants the transition between cryptogams and phanerogams has been practically bridged over by the discovery that certain fern-like plants of the Coal Measures—the Cycadofilices, supposed to be true ferns, are really seed-bearing plants and not ferns at all, but phanerogams of a primitive type, allied to the cycads and gymnosperms. They have been rechristened Pteridosperms by Scott, who, together with F. Oliver and Seward, has been the chief discoverer in this most interesting field.

By their fossil remains whole series of new genera of extinct mammals have been traced through the tertiary strata of North America and their genetic connections established; and from yet older strata of the same prolific source we have almost complete knowledge of several genera of huge extinct Dinosauria of great variety of form and habit.

The discoveries by Seeley at the Cape, and by Amalitzky in North Russia of identical genera of Triassic reptiles, which in many respects resemble the Mammalia and constitute the group Theromorpha, is also a prominent feature in the palæontology of the past twenty-five years. Nor must we forget the extraordinary Silurian fishes discovered and described in Scotland by Professor Traquair. The most important discovery of the kind of late years has been that of the Upper Eocene and Miocene Mammals of the Egyptian Fayum, excavated by the Egyptian Geological Survey, and by Dr. Andrews, of the Natural History Museum, who has described and figured the remains. They include a huge four-horned animal as big as a rhinoceros, but quite peculiar in its characters—the Arisinoitherium—and the ancestors of the elephants, a group which was abundant in Miocene and Pliocene times in Europe, and Asia, and in still later times in America, and survives at the present day in its representatives the African and Indian elephant. One of the European extinct elephants—the Tetrabelodon—had, we have long known, an immensely long lower jaw with large chisel-shaped terminal teeth. It had been suggested by me that the modern elephant's trunk must have been derived from the soft upper jaw and nasal area, which rested on this elongated lower jaw, by the shortening (in the course of natural selection and modification by descent) of this long lower jaw, to the present small dimensions of the elephant's lower jaw, and the consequent down-dropping of the unshortened upper jaw and lips, which thus become the proboscis. Dr. Andrews has described from Egypt and placed in the Museum in London specimens of two new genera—one Palæomastodon, in which there is a long powerful jaw, an elongated face, and an increased number of molar teeth; the second, Meritherium, an animal with a hippopotamus-like head, comparatively minute tusks, and a well-developed complement of incisor, canine, and molar teeth, like a typical ungulate mammal. Undoubtedly we have in these two forms the indications of the steps by which the elephants have been evolved from ordinary-looking pig-like creatures of moderate size, devoid of trunk or tusks. Other remains belonging to this great mid-African Eocene fauna indicate that not only the Elephants but the Sirenia took their origin in this area. Amongst them are also gigantic forms of Hyrax, like the little Syrian coney and many other new mammals and reptiles.

Another great area of exploration and source of new

things has been the southern part of Argentina and Patagonia, where Ameghino, Moreno, and Scott, of Princeton, have brought to light a wonderful series of extinct ant-eaters, armadilloes, huge sloths, and strange ungulates, reaching back into early Tertiary times. But most remarkable has been the discovery in this area of remains which indicate a former connection with the Australian land surface. This connection is suggested by the discovery in the Santa Cruz strata, considered to be of early Tertiary date, of remains of a huge horned tortoise which is generically identical with one found fossil in the Australian area of later date, and known as Miolania. In the same wonderful area we have the discovery in a cave of the fresh bones, hairy skin, and dung of animals supposed to be extinct, viz., the giant sloth, Mylodon, and the peculiar horse, Onohippidium. These remains seem to belong to survivors from the last submergence of this strangely mobile land-surface, and it is not improbable that some individuals of this "extinct" fauna are still living in Patagonia. The region is still unexplored, and those who set out to examine it have, by some strange fatality, hitherto failed to carry out the professed purpose of their expeditions.

I cannot quit this immense field of gathered fact and growing generalisation without alluding to the study of animal embryology and the germ-layer theory, which has to some extent been superseded by the study of embryonic cell-lineage, so well pursued by some American microscopists. The great generalisation of the study of the germ-layers and their formation seems to be now firmly established—namely, that the earliest multicellular animals were possessed of one structural cavity, the enteron, surrounded by a double layer of cells, the ectoderm and endoderm. These Enterocœla or Cœlentera gave rise to forms having a second great body cavity, the cœlom, which originated not as a split between the two layers, as was supposed twenty-five years ago by Haeckel and Gegenbaur and their pupils, but by a pouching of the enteron to form one or more cavities in which the reproductive cells should develop—pouchings which became nipped off from the cavity of their origin, and formed thus the independent cœlom. The animals so provided are the Cœlomocœla (as opposed to the Enterocœla), and comprise all animals above the polyps, jelly-fish, corals, and sea-anemones. It has been established in these twenty-five years that the cœlom is a definite structural unit of the higher groups, and that outgrowths from it to the exterior (cœlomoducts) form the genital passages, and may become renal excretory organs also. The vascular system has not, as it was formerly supposed to have. any connection of origin with the cœlom, but is independent of it, in origin and development, as also are the primitive and superficial renal tubes known as nephridia. These general statements seem to me to cover the most important advance in the general morphology of animals which we owe to embryological research in the past quarter of a century. (See the Introduction to Part II. of "A Treatise on Zoology," edited by E. Ray Lankester; London, A. and C. Black).

Before leaving the subject of animal morphology I must apologise for my inability to give space and time to a consideration of the growing and important science of anthropology, which ranges from the history of human institutions and language to the earliest prehistoric bones and implements. Let me therefore note here the discovery of the cranial dome of *Pithecanthropus* in a river gravel in Java—undoubtedly the most ape-like of human remains, and of great age; and, further, the Eoliths of Prestwich, in the human authorship of which I am inclined to believe, though I should be sorry to say the same of all the broken flints to which the name "Eolith" has been applied. The systematic investigation and record of savage races have taken on a new and scientific character. Such work as Baldwin Spencer's and Haddon's in Australasia furnish examples of what is being done in this way.

To be continued).

## THE COAL-TAR COLOUR JUBILEE.

In connection with the Perkin Jubilee, celebrated last week, a correspondent has drawn our attention to the following extract, written by J. C. Brough, which appeared in *Fun* fifty years ago. At this holiday season, when laboratory work is becoming temporarily less strenuous, we make no apology for presenting it to our readers.

### COMIC CHEMICALS. (From *Fun*).

In the July number of the *Chemical Society's Journal* there is an essay (Paper read June 15, 1856) "On the Action of Nascent Hydrogen on Azodinaphthyldiamine"—a subject which is hardly likely to rivet the attention of non-professional readers, especially as it is dealt with in prose. Treated metrically, perhaps, it might appeal to a wider circle; in this conviction we have thrown the treatise into melodious verse, confining ourselves, as much as possible, to words of less than ten syllables. We dedicate our lyric to Mr. W. H. Perkin, the author of the original essay in the *C. S. J.*; and we call it, from circumstances under which it was composed—

An Alcoholic Solution. (*Air: "Guy Fawkes"*).

The many metamorphoses which bodies undergo, sirs,
When subjected to hydrogen, all chemists ought to know, sirs;
But only one who occupies the proud position *I* am in
Can calculate its action on Azodinaphthyldiamine.
Bow, wow, wow, &c.

That hydrogen, in such a case, is certain to decolorize,
Can hardly be a question for a man who has a skull or eyes.
Solutions alcoholic must be saturated clammily
In nipperkins or pipperkins (you know the Perkin family).
Bow, wow, wow, &c.

You turn it to a palish buff, supposing you begin, sirs,
By carefully digesting it with granulated tin, sirs;
Then borrow some decanters, just to bottle the solution up;
But don't attempt to drink it, or you 'll knock your constitution up.
Bow, wow, wow, &c.

With sulphuretted hydrogen the residue is treated;
For *my* part, it 's a sort of treat I should not want repeated.
Then filter pretty quickly—if you filter *slow*, 't will militate
Against the operation it may otherwise facilitate.
Bow, wow, wow, &c.

The residue looks dirty, and of course you 'll say, "I 'm sure if I 'd
A little boiling water, I should like to get it purified."
Add hydrochloric acid—it will be of use in hurrying
The crystallising process, and will save a deal of worrying.
Bow, wow, wow, &c.

But no! If we were to go on at this rate, the next number of *Fun* would have to appear in three large volumes; and perhaps the Editor would n't like to be thought eccentric. However, if any respectable chemist and druggist is dying to learn what the action of nascent hydrogen on azodinaphthyldiamine may be, let him send a stamped envelope and a dozen boxes of his best ipecacuanha lozenges to 80 Fleet Street, and the envelope shall be returned without loss of time.

**Influence of Substituents on the Tint of Malachite Green.**—E. Noelting and P. Gerlinger.—The effects of nitro and hydroxyl groups upon the colour of malachite green have been investigated by others, and the authors have now determined the corresponding effects of the methoxyl group, chlorine derivatives, and sulpho-derivatives. The first of these in the ortho-position renders the colour more blue, in the para more yellow, and has no effect when in the meta position. The halogen produces a more decided blue tint in the ortho-position than the nitro group. —*Berichte*, xxxix., No. 9.

## NOTES OF A COURSE OF LECTURES ON THE OLD AND NEW CHEMISTRY.†

### II. Extracts from different Authors Relating to the New Chemistry.

By Prof. Sir JAMES DEWAR, F.R.S., &c.

(Continued from p. 40).

*Faraday's Discovery of Electro-chemical Decomposition.—Tyndall.*

"His paper on electro-chemical decomposition, received by the Royal Society on January 9, 1834, opens up with the proposal of a new terminology. He would avoid the word 'current' if he could. He does abandon the word 'poles' as applied to the ends of a decompositing cell, because it suggests the idea of attraction, substituting for it the perfectly neutral term Electrodes. He applied the term Electrolyte to every substance which can be decomposed by the current, and the act of decomposition he called Electrolysis. All these terms have become current in science. He called the positive electrode the Anode, and the negative one the Cathode, but these terms, though frequently used, have not enjoyed the same currency as the others. The terms Anion and Cation, which he applied to the constituents of the decomposed electrolyte, and the term Ion, which included both anions and cations, are still less frequently employed.

"Faraday now passes from terminology to research; he sees the necessity of quantitative determinations, and seeks to supply himself with a measure of voltaic electricity. This he finds in the quantity of water decomposed by the current. He tests this measure in all possible ways to assure himself that no error can arise from its employment.

"Sending the same current through a series of cells containing mixtures of sulphuric acid and water of different strengths, he finds, however the proportion of acid to water might vary, the same amount of gas to be collected in all the cells. A crowd of facts of this character forced upon Faraday's mind the conclusion that the amount of electro-chemical decomposition depends, not upon the size of the electrodes, not upon the intensity of the current, not upon the strength of the solution, but solely upon the quantity of electricity which passes through the cell. The quantity of electricity he concludes is proportional to the amount of chemical action. On this law Faraday based the construction of his celebrated Voltameter, or Measurer of Voltaic electricity.

"With the indications of his voltameter he compared the decomposition of other substances both singly and in series. He submitted his conclusions to numberless tests. He purposely introduced secondary actions. He endeavoured to hamper the fulfilment of those laws which it was the intense desire of his mind to see established. But from all these difficulties emerged the golden truth, that under every variety of circumstances the decompositions of the voltaic current are as definite in their character as those chemical combinations which gave birth to the atomic theory. This law of electro-chemical decomposition ranks, in point of importance, with that of definite combining proportions in chemistry."

*Chemistry and New Elements.—Herschel.*

"It is, of all the sciences, perhaps, the most completely an experimental one; and even its theories are, for the most part, of that generally intelligible and readily applicable kind, which demand no intense concentration of thought, and lead to no profound mathematical researches. The simple process of inductive generalisation, grounded on the examination of numerous facts, all of them presenting considerable intrinsic interest, has sufficed, in most instances, to lead, by a clear and direct road, to its highest laws yet known. But, on the other hand, these laws, when stated, are not yet fully sufficient to lead us, except in very limited cases, to a deductive knowledge of particulars never before examined, at least, not without great caution, and constant appeal to experiment as a check on our reasoning; so that we are justified in regarding the axioms of chemistry, the true handles of deductive reasoning, as still unknown, and, perhaps, likely long to remain so. This is no fault of its cultivators, who have comprised in their list the highest and most varied talents and industry, but of the inherent complexity of the subject, and the infinite multitude of causes which are concerned in the production of every, even the simplest, chemical phenomenon.

"And first, then, with reference to the discovery of new elements, it will be observed, that philosophical chemistry no more aims at determining the one essential element out of which all matter is framed—the one ultimate principle of the universe—than astronomy at discovering the origin of the planetary movements in the application of a determinate projectile force in a determinate direction, or geology at ascending to the creation of the earth. There may be such an element. Some singular relations which have been pointed out in the atomic weights of bodies seem to suggest to minds fond of speculation that there is; but philosophical chemistry is content to wait for some striking fact, which may either occur unexpectedly or be led to by the slow progress of enlarged views, to disclose to us its existence. Still, the multiplication of so-considered elementary bodies has been considered by some as an inconvenience. We confess we do not coincide with this view. Whatever they be, the obstinacy with which they resist decomposition shows that they are ingredients of a very high and primary importance in the economy of nature; and such as, in any state of science, it would be indispensably necessary to be perfectly familiar with. Like particular theorems in geometry, which, though not rising to the highest point of generality, have yet their several scopes and ranges of extensive application, they must be well and perfectly understood in all their bearings. Should we ever arrive at an analysis of these bodies, the chemical properties of the new elements which will then come into view will be known only by our knowledge of these, or of other compounds of the same class, which they may be capable of forming. Not but that such an analysis would be a most important, and indeed triumphant achievement, and change the face of chemistry; but it would undo nothing that has been done, and render useless no point of knowledge which we have yet arrived at."

*Principal Features in the Progress of the New Chemistry to the Year 1833.—Sir John Herschel.*

1. The discovery of the proximate, if not the ultimate, elements of all bodies, and the enlargement of the list of known elements to its present extent of between fifty and sixty substances.

2. The development of the doctrine of latent heat by Black, with its train of important consequences, including the scientific theory of the steam engine.

3. The establishment of Wenzel's law of definite proportions on his own experiments, and those of Richter, a discovery subsequently merged in the greater generality of the atomic theory of Dalton.

4. The precise determination of the atomic weights of the different chemical elements, mainly due to the astonishing industry of Berzelius and his unrivalled command of chemical resources, as well as to the researches of the other chemists of the Swedish and German School, and of our countryman, Dr. Thomson.

5. The assimilation of gases and vapours, by which we are led to regard the former, universally as particular cases of the latter, a generalisation resulting chiefly from the experiments of Faraday on the condensation of the gases, and those of Gay-Lussac and Dalton, on the laws of their expansion by heat compared with that of vapours.

6. The establishment of the laws of the combination of gases and vapours by definite volumes, by Gay-Lussac.

7. The discovery of the chemical effects of electricity

† Delivered at the Royal Institution, May 26th, 1906.

and the decomposing agency of the Voltaic pile by Nicholson and Carlisle; the investigation of the laws of such decompositions, by Berzelius and Hisinger; the decomposition of the alkalis, by Davy; and the consequent introduction into chemistry of new and powerful agents in their metallic bases.

8. The application of chemical analysis to all the objects of organised or unorganised nature, and the discovery of the ultimate constituents of all, and the proximate ones of organic matter, and the recognisance of the important distinctions which appear to divide these great classes of bodies from each other.

9. The applications of chemistry to innumerable processes in the arts, and among other useful purposes to the discovery of the essential medical principles in vegetables, and to important medicaments in the mineral kingdom.

10. The establishment of the intimate connection between chemical composition and crystalline form, by Haüy and Vauquelin, with the successive rectifications the statement of that connection has undergone in the hands of Mitscherlich, Rose, and others, with the progress of chemical crystallographical knowledge.

(To be continued).

# PROCEEDINGS OF SOCIETIES.

## CHEMICAL SOCIETY.

*Ordinary Meeting, July 5th, 1906.*

Prof. R. Meldola, F.R.S., President, in the Chair.

(Concluded from p. 45).

141. "*The Alkylation of Rhamnose.*" By Thomas Purdie and Charles Robert Young.

By complete methylation with silver oxide and methyl iodide, acetone- and methyl-rhamnosides yield respectively *dimethyl acetonerhamnoside* and *trimethyl methylrhamnoside*, and by hydrolysing these compounds *di-* and *tri-methylrhamnose* respectively are obtained. The rhamnose derivatives described are liquids, but, all of them excepting dimethyl rhamnose being volatile without decomposition, it was possible to isolate them by fractional distillation under reduced pressure.

Dimethyl- and trimethyl-rhamnose give crystalline phenylhydrazones, and display the ordinary properties of reducing sugars. Trimethyl rhamnose is re-converted into trimethyl methylrhamnoside by condensation with methyl alcohol and also by the silver oxide method of alkylation; the former process gives mainly the α-form of the aldoside, the latter a mixture composed largely of the β-form. The presence of the β-isomeride was recognised not only by its rotatory power, but also by the rapidity of its hydrolysis. The rotatory powers of the substances described fall into line with those of glucose and its corresponding derivatives.

142. "*The Alkylation of* l-*Arabinose.*" By Thomas Purdie and Robert Evstafieff Rose.

By methylating Fischer's α-methylarabinoside with silver oxide and methyl iodide, *trimethyl-α-methylarabinoside* is obtained in large well-formed crystals (m. p. 43—45°), and by hydrolysing this with dilute hydrochloric acid *trimethyl arabinose* is produced. This substance is a liquid (b. p. 148—152°, 19 m.m.), but otherwise it exhibits the usual properties of a reducing sugar. It can be methylated by condensation with methyl alcohol, and also by treatment with methyl iodide and silver oxide, the product in both cases being a mixture of the isomeric trimethyl methylarabinosides. The condensation process yields the crystalline ε-isomeride in large proportion, the silver oxide process mainly the β-isomeride. The latter substance is apparently a liquid, and it could not be isolated, but its presence in the mixture was recognised by its undergoing hydrolysis more rapidly than the isomeric α-form.

In preparing Fischer's α-methylarabinoside, a small quantity of the *β-methylarabinoside* was obtained in crystalline prisms melting at 115—117°.

With respect to rotatory power, the isomeric methylarabinosides and trimethyl methylarabinosides show relations similar to those of the corresponding derivatives of *d*-glucose.

143. "*The Esters of Triacetic Lactone and Triacetic Acid.*" By Foster Sproxton.

*Ethyl triacetate*, $Me{\cdot}CO{\cdot}CH_2{\cdot}CO{\cdot}CH_2{\cdot}CO_2Et$, is formed by heating triacetic lactone with dry alcohol in sealed tubes, and may be obtained pure by decomposing its copper salt with sulphuretted hydrogen. It gives a deep red coloration with ferric chloride.

The *ethyl* and *methyl* salts of triacetic lactone have been prepared by the action of ethyl and methyl iodides on the silver salt of the lactone. The ethyl ester could not be obtained in the pure condition. Like the analogous esters of dehydracetic acid, they have an acid reaction in aqueous solution. This property has been shown to be due, in both the triacetic lactone and dehydracetic acid derivatives, to partial hydrolysis of the esters by water. Complete hydrolysis takes place on boiling, and the parent lactone can be recovered from the solution.

144. "*Optically Active Reduced Naphthoic Acids.* Part II. *The Resolution of the Tetrahydronaphthoic Acids.*" By Robert Howson Pickard and Joseph Yates.

1 : 2 : 3 : 4-Tetrahydro-1-naphthoic acid and 1 : 2 : 3 : 4-tetrahydro-2-naphthoic acid have each been resolved into their optical antipodes by the fractional crystallisation from acetone of the *l*-menthylamine salts.

The lævo-isomeride of the first has $[M]_D$ − 28·1° in chloroform and − 92·1° in benzene, that of the second having $[M]_D$ − 91·2° in chloroform and − 87·9° in benzene. The sodium salts when dissolved in water have respectively $[M]_D$ − 21·1° and − 90·5°.

145. "*The Velocity of Chemical Change in the Pentamethylene Series.*" By N. Menschutkin, sen.

The general results of the study of the velocity of chemical change in polymethylene derivatives are as follows:—

1. The formation of the closed polymethylene chain from an open saturated chain of normal structure proceeds with increase of velocity. The maximum increase occurs in the formation of the pentamethylene ring; in the case of the hexamethylene ring the increase is less, and the heptamethylene ring is formed with the minimum increase of velocity.

2. The increase of velocity at the closing of the open chain is not a specific property of the polymethylene ring, but is a general phenomenon observed in the formation of all closed chains, alicyclic and heterocyclic.

3. The constants of velocity decrease according as the number of methylene groups in the polymethylene rings increases. The decrease is of the same order as is observed in the homologous series of open chain saturated carbon compounds of normal structure.

4. The secondary polymethylene alcohols, in which the hydroxyl group is attached to the carbon atom of the ring, are typical secondary alcohols. Their esterification constants are higher than those of the saturated secondary alcohols of normal structure. Hence, the polymethylene alcohols give higher constants than all of the secondary alcohols studied. The constants of the derivatives of *cyclo*pentanol are the highest; *cyclo*hexanol gives much lower values, and *cyclo*heptanol still less.

5. The side chain combined with the carbon atom united with the hydroxyl group gives rise to the formation of the polymethylene tertiary alcohols. Their esterification constants are low, but esterification proceeds regularly; this is not the case with saturated tertiary alcohols, but is characteristic of phenols.

6. When the side chains are in the ortho- and diortho-positions, a great decrease in the esterification constants is observed. This effect, commonly ascribed to the benzene ring alone, is a general property of all classes of chains

whether open or closed, and containing carbon or other elements.

7. When the side chain is in the position 3 or 4 of the polymethylene ring, an increase of esterification constants is observed, so much so that in the hexamethylene series the value of the constant of the first member of the series is exceeded.

8. This property is not confined to the polymethylene ring, but applies generally to ringed systems, alicyclic and heterocyclic. As open chain compounds show no such increase of velocity, this is an important character of the closed chains.

9. When a hexamethylene ring is introduced into the open chain of an alcohol, the decrease of the esterification constant is much more than is effected by the benzene ring.

10. Hexamethylene, like hexane, exerts a very considerable retarding influence when used as a solvent in these reactions.

146. "*Hydrolysis of Ammonium Salts by Water.*" By ERNEST GEORGE HILL.

The author aspirated a measured volume of air through solutions of different ammonium salts, the strengths of the solutions being normal, fifth-normal, and twenty-fifth-normal. The ammonia passing over was absorbed in water, or, when the amount was large, in acid. In the first case, the ammonia was estimated from the conductivity of the solution; in the latter case, by titration. It was found that for strong acids the equation—

$$\frac{C_{\text{Acid}} \times C_{\text{Base}}}{C_{\text{Salt}}} = K,$$

and for weak acids—

$$\frac{C_{\text{Acid}} \times C_{\text{Base}}}{C^{2}_{\text{Salt}}} = K$$

holds good for the concentrations of salt used.

The constants obtained in the case of the salts of monobasic acids are inversely proportional to the molecular conductivities of the acids, and agree well with the values obtained for the strength of the acids by the various dynamical methods. In the case of dibasic acids, the constants are irregular. It is shown that the constant must depend on both the first and second ionisation-coefficients of the acids.

The author described the method employed for estimating ammonia by taking the resistance of its solution in conductivity water and comparing this with the resistance curve of ammonia. The method gave good results with solutions containing from 0·00027 to 0·009 per cent.

147. "*The Addition of Alkyl Halides to Alkylated Sugars and Glucosides.*" By JAMES COLQUHOUN IRVINE and AGNES MARION MOODIE.

When solutions of the equilibrium mixture of tetramethyl glucose in ordinary organic solvents are cooled from +20° to −20°, the specific rotations undergo very little alteration, and, on re-heating to the initial temperature, the values originally found for the rotatory powers are exactly duplicated. When, however, an alkyl halide is used as solvent, the specific rotation at first increases slightly with fall of temperature and then rapidly diminishes on further cooling. On re-heating the cooled solution to 20°, distinct downward multi-rotation was observed before the initial value was reached. The same regularities were shown by solutions of molecular proportions of the sugar and alkyl halides or hydrogen chloride in carbon tetrachloride.

The results point to the formation, during cooling, of oxonium compounds of the sugar with alkyl halides, and the α-form of the aldose appears to be more reactive than the β-isomeride. This was shown by a cycle of changes in specific rotation observed in the case of a solution in isopropyl iodide which had been cooled from 20° to 0°:—(*a*) Rapid decrease at 0°, due to oxonium formation; (*b*) subsequent upward multi-rotation at 0°, owing to the partial conversion, β→α, in the uncombined sugar; (*c*) on re-heating to 20°, owing to dissociation of the oxonium compound, a rapid increase at constant temperature took place, followed by (*d*) downward multi-rotation at 20° to the initial value.

Tetramethyl α-methylglucoside also behaves abnormally when cooled in ethyl iodide solution, but the β-isomeride gives no indication of addition of the solvent. Comparable results were obtained with tetramethyl mannose and tetramethyl α-methylmannoside, but non-alkylated sugars or glucosides, when examined in mixtures of methyl alcohol and alkyl iodides, gave negative results.

The following notes have been received since the meeting:—

148. "*Note on the Preparation of Ethyl Acetonedicarboxylate.*" By ERNEST ORMEROD.

In attempting to prepare ethyl acetonedicarboxylate, on fractionating the crude ester prepared by the method described by v. Pechmann (*Annalen*, 1891, cclxi., 160) under reduced pressure, only a small quantity of volatile material was obtained, which on examination proved to be principally acetoacetic ester. The main product, which on cooling solidified to a white crystalline mass, was ethylorcintricarboxylate.

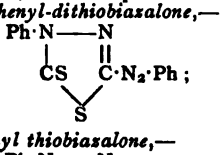
Wolfman and v. Pechmann (*Ber.*, 1898, xxxi., 2014) have shown that ethyl orcintricarboxylate is formed if an alcoholic solution of acetonedicarboxylic acid saturated with hydrogen chloride is allowed to stand for two or three weeks, and it was at first thought possible that the condensation had been brought about in this way during the preparation, but on examination it was found that the crude ester contained only a very small quantity of the orcinol derivative. It appeared very strange that the condensation should take place so readily, as according to Jerdan (*Trans.*, 1899, lxxiii., 808) the pure ester may be heated at 180° for a considerable time without any condensation taking place. Finally, it was found that the condensation was brought about by the presence of a small quantity of calcium chloride which had been dissolved by the alcohol-ethereal solution of the ester. This view was shown to be correct by the fact that if the pure ester be heated with a trace of calcium chloride at 180° for a short time, the amount of orcinol derivative formed corresponds to 4 per cent of the theoretical. If the ethereal solution of the crude ester is dried over fused sodium sulphate, it may be distilled under reduced pressure without any condensation taking place.

During an attempt to prepare pure methyl acetonedicarboxylate, Dootson (*Trans.*, 1900, lxxiv., 1196) obtained a crude product which, on distillation under reduced pressure, condensed very readily to form methyl orcintricarboxylate, and he came to the conclusion that the methyl ester cannot be distilled without this condensation taking place. It seems improbable that the methyl ester should differ in respect from the ethyl ester, and, although Dootson does not state how the ethereal solution was dried, it is probable that the crude ester contained some inorganic substance which promoted the condensation.

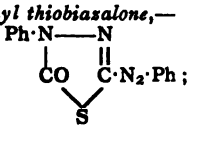
149. "*The Interaction of Nitroformazyl, Carbon Bisulphide, and Potassium Hydroxide. A Contribution to the Chemistry of the Thiobiazalones and the Xanthates.*" By ERNEST ORMEROD.

The peculiar position of the nitro-group in nitroformazyl confers on this compound very abnormal properties; thus, by the interaction of nitroformazyl, carbon bisulphide, and potassium hydroxide, three compounds are obtained:—

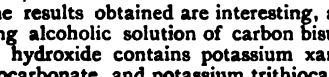
1-*Phenyl*-3-*azophenyl-dithiobiazalone*,—




1-*phenyl*-3-*azophenyl thiobiazalone*,—



and 1-*phenyl*-3-*azophenyl*-2-*thioaziethane*,—



The three compounds are formed in varying quantities, depending on the solvent used and the conditions under which the experiment is carried out. Using alcohol as solvent, at the ordinary temperature the monothiobiazalone is almost exclusively formed, whilst if the interaction takes place at higher temperatures all three compounds are produced simultaneously; on using acetone or carbon bisulphide as the solvent, only the dithiobiazalone is formed,

The results obtained are interesting, as proving that a boiling alcoholic solution of carbon bisulphide and potassium hydroxide contains potassium xanthate, potassium dithiocarbonate, and potassium trithiocarbonate.

The author finds that the nitroformazyl is first reduced to formazylmercaptan, which is then acted on by the potassium xanthate, forming the dithiobiazalone, and by the potassium dithiocarbonate, forming the monothiobiazalone. The thioaziethane is apparently produced by the interaction of the potassium trithiocarbonate and the nitroformazyl.

The constitution of the biazalones obtained was proved by an examination of their decomposition products and by synthesis; the dithiobiazalone was synthesised from formazylmercaptan and thiophosgene, and the monothiobiazalone from formazylmercaptan and phosgene.

150. "*Aldehydrol and the Hydrates of Compounds containing a Carbonyl Group.*" By William Morris Colles.

Concentrated aqueous solutions of aldehyde, acetone, formic, acetic, monochloroacetatic, and trichloroacetic acids were cooled to low temperatures in an apparatus fitted with a combined filtering and stirring tube. The solutions, made up quantitatively in definite molecular proportions, were contained in a long stoppered weighing tube into which the combined filtering and stirring tube fitted. This in turn was clamped inside a large vacuum vessel containing absolute alcohol, which, when cooled by liquid air, constituted the freezing mixture. Cooling was brought about very gradually, and the solutions were very rapidly stirred. Several crystalline hydrates were obtained, the mother-liquor being separated as soon as crystallisation had occurred. The following compounds of special interest were obtained:—Aldehydrol, $CH_3CH(OH)_2$, at $-90°$, a hydrol of formic acid, possibly *ortho*-formic acid, $HC(OH)_3$; *ortho*-acetic acid, $CH_3C(OH)_3$; and *ortho*-monochloroacetic acid, $CH_2ClC(OH)_3$. The analyses of the last two compounds, owing to experimental difficulties, were not very close. Acetone gave no result, and with trichloroacetic acid a hydrate containing 3 mols. of water was obtained. The hydrates of formic acid were fairly thoroughly investigated, and the following were obtained in a fairly pure crystalline condition: — $CH_2O_2,4H_2O$, $4CH_2O_2,7H_2O$, $4CH_2O_2,3H_2O$, $3CH_2O_2,2H_2O$.


UNIVERSITY OF DURHAM.

**ARMSTRONG COLLEGE, Newcastle-upon-Tyne.**

Principal—Sir ISAMBARD OWEN, D.C.L., M.D.

SESSION OF 1906-7.

MATRICULATION and EXHIBITION EXAMINATIONS, SEPTEMBER 24—29th.

OPENING of TERM, OCTOBER 2nd.

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MINISTRY OF EDUCATION.

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ASSISTANT TO THE PROFESSOR OF CHEMISTRY.

The appointment is for two years, and may be renewed at the end of that time. Applicants should forward copies of testimonials, and such other particulars as are mentioned below.

The pay of the Post is £E320 per annum, the Egyptian pound being worth 6d. more than the pound sterling.

Private practice is not allowed.

It is to be distinctly understood that the appointment gives no claim to pension or indemnity.

The Government reserves to itself the right to dismiss the Assistant for misconduct or incapacity.

In the Government Schools, as in all State Administrations in Egypt, Sunday is a working day. The Schools are closed on Fridays.

Leave will be granted on the same terms as to other Government Officials. The possibility of taking leave, and the period of the year at which it is granted, depend upon the exigencies of the service.

Pay commences from date of arrival in Cairo. On taking up his duties in Cairo, the Assistant will receive one month's pay in lieu of passage money.

All applicants should attach a certificate from a legally qualified Medical man, stating that, in his opinion, the candidate would pass a first-class life for insurance purposes.

All applicants should state—

Their training and qualifications in Analytical Chemistry,
Their age,
What foreign languages they know, and
If they can be in Cairo by October 1st.

The latest Mail by which applications may be posted will leave London on Friday, August 31st. Applications to be addressed The Director, Government School of Medicine, Cairo, Egypt.

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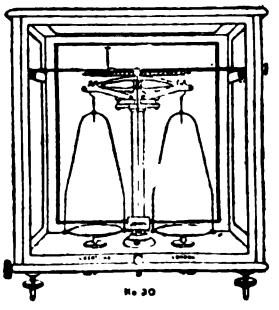


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# BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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## INAUGURAL ADDRESS OF THE PRESIDENT,

Prof. E. Ray Lankester, M.A., LL.D., D.Sc., F.R.S., F.L.S., Director of the Natural History Departments of the British Museum.

(Continued from p. 56).

*Physiology of Plants and Animals.*—Since I have only time to pick the most important advances in each subject for brief mention, I must signalise in regard to the physiology of plants the better understanding of the function of leaf-green or chlorophyll due to Pringsheim, and to the Russian Timiriaseff, the new facts as to the activity of stomata in transpiration discovered by Horace Brown, and the fixation of free nitrogen by living organisms in the soil, and by organisms (*Bacillus radicola*) parasitic in the rootlets of leguminous plants, which thus benefit by a supply of nitrogenous compounds which they can assimilate.

Great progress in the knowledge of the chemistry of the living cells or protoplasm of both plants and animals has been made by the discovery of the fact that ferments or enzymes are not only secreted externally by cells, but exist active and preformed *inside* cells. Büchner's final conquest of the secret of the yeast-cell by heroic mechanical methods—the actual grinding to powder of these already very minute bodies—first established this, and now successive discoveries of intracellular ferments have led to the conclusion that it is probable that the cell respires by means of a respiratory "oxydase," builds up new compounds and destroys existing ones, contracts and accomplishes its own internal life by ferments. Life thus (from the chemical point of view) becomes a chain of ferment actions. Another most significant advance in animal physiology has been the sequel (as it were) of Bernard's discovery of the formation of glycogen in the liver, a substance not to be excreted, but to be taken up by the blood and lymph, and in many ways more important than the more obvious formation of bile which is thrown out of the gland into the alimentary canal. It has been discovered that many glands, such as the kidney and pancreas and the ductless glands, the suprarenals, thyroid, and others, secrete indispensable products into the blood and lymph. Hence, myxœdema, exophthalmic goitre, Addison's disease, and other disorders have been traced to a deficiency or excess of internal secretions from glands formerly regarded as interesting but unimportant vestigial structures. From these glands have in consequence been extracted remarkable substances on which their peculiar activity depends. From the suprarenals a substance has been extracted which causes activity of all those structures which the sympathetic nerve system can excite to action; the thyroid yields a substance which influences the growth of the skin, hair, bones, &c.; the pituitary gland, an extract which is a specific urinary stimulant. Quite lately the mammalian ovary has been shown by Starling to yield a secretion which influences the state of nutrition of the uterus and mammæ. Had I time, I might say a great deal more on topics such as these—topics of almost infinite importance; but the fact is that the mere enumeration of the most important lines of progress in any one science would occupy us for hours.

Nerve-physiology has made immensely important advances. There is now good evidence that all excitation of one group of nerve-centres is accompanied by the *concurrent inhibition* of a whole series of groups of other centres, whose activity might interfere with that of the group excited to action. In a simple reflex flexure of the knee the motor-neurones to the flexor muscles are excited, but concurrently the motor-neurones to the extensor muscles are thrown into a state of inhibition, and so equally with all the varied excitations of the nervous system controlling the movements and activities of the entire body.

The discovery of the continuity of the protoplasm through the walls of the vegetable cell by means of connecting canals and threads is one of the most startling facts discovered in connection with plant-structure, since it was held twenty years ago that a fundamental distinction between animal and vegetable structure consisted in the boxing-up or encasement of each vegetable cell-unit in a case of cellulose, whereas animal cells were not so imprisoned, but freely communicated with one another. It perhaps is on this account the less surprising that lately something like sense-organs have been discovered on the roots, stems, and leaves of plants, which, like the otocysts of some animals, appear to be really "statocytes," and to exert a varying pressure according to the relations of these parts of the plant to gravity. There is apparently something resembling a perception of the incidence of gravity in plants which reacts on irritable tissues, and is the explanation of the phenomena of geotropism. These results have grown out of the observations of Charles Darwin, followed by those of F. Darwin, Haberlandt, and Nemec.

A few words must be said here as to the progress of our knowledge of cell-substance, and what used to be called the protoplasm question. We do not now regard protoplasm as a chemical expression, but, in accordance with von Mohl's original use of the word, as a structure which holds in its meshes many and very varied chemical bodies of great complexity. Within these twenty-five years the "centrosome" of the cell-protoplasm has been discovered, and a great deal has been learnt as to the structure of the nucleus and its remarkable stain-taking bands, the chromosomes. We now know that these bands are of definite fixed number, varying in different species of plants and animals, and that they are halved in number in the reproductive elements—the spermatozoid and the ovum—so that on union of these two to form the fertilised ovum (the parent cell of all the tissues), the proper specific number is attained. It has been pretty clearly made out by cutting up large living cells—unicellular animals—that the body of the cell alone, without the nucleus, can do very little but move and maintain for a time its chemical status. But it is the nucleus which directs and determines all definite growth, movement, secretion, and reproduction. The simple protoplasm, deprived of its nucleus, cannot form a new nucleus—in fact, can do very little but exhibit irritability. I am inclined to agree with those who hold that there is not sufficient evidence that any organism exists at the present time which has not both protoplasm and nucleus—in fact, that the simplest form of life at present existing is a highly complicated structure—a nucleated cell. That does not imply that simpler forms of living matter have not preceded those which we know. We must assume that something more simple and homogeneous than the cell, with its differentiated cell-body or protoplasm, and its cell kernel or nucleus, has at one time existed. But the various supposed instances of the survival to the present day of such simple living things—described by Haeckel and others—have one by one yielded to improved methods of microscopic examination, and proved to be differentiated into nuclear and extra-nuclear substance.

The question of "spontaneous generation" cannot be said to have been seriously revived within these twenty-five years. Our greater knowledge of minute forms of life, and the conditions under which they can survive, as well as our improved microscopes and methods of experiment and observation, have made an end of the arguments and instances of supposed abiogenesis. The accounts which

have been published of "radiobes," minute bodies arising in fluids of organic origin when radium salts have been allowed to mix in minute quantities with such fluids, are wanting in precision and detail, but the microscopic particles which appear in the circumstances described seem to be of a nature identical with the minute bodies well known to microscopists, and recognised as crystals modified by a colloid medium. They have been described by Rainey, Harting, and Ord, on different occasions, many years ago. They are not devoid of interest, but cannot be considered as having any new bearing on the origin of living matter.

*Psychology*.—I have given a special heading to this subject because its emergence as a definite line of experimental research seems to me one of the most important features in the progress of science in the past quarter of a century. Thirty-five years ago we were all delighted by Fechner's psycho-physical law, and at Leipzig I, with others of my day, studied it experimentally in the physiological laboratory of that great teacher, Carl Ludwig. The physiological methods of measurement (which are the physical ones) have been more and more widely, and with guiding intelligence and ingenuity, applied since those days to the study of the activities of the complex organs of the nervous system which are concerned with "mind" or psychic phenomena. Whilst some enthusiasts have been eagerly collecting ghost stories and records of human illusion and fancy, the serious experimental investigation of the human mind, and its forerunner the animal mind, has been quietly but steadily proceeding in truly scientific channels. The science is still in an early phase—that of the collection of accurate observations and measurements—awaiting the development of great guiding hypotheses and theories. But much has been done, and it is a matter of gratification to Oxford men that through the liberality of the distinguished electrician, Mr. Henry Wilde, F.R.S., a lectureship of Experimental Psychology has been founded in the University of Oxford, where the older studies of Mental and Moral Philosophy, Logic, and Metaphysics have so strong a hold, and have so well prepared the ground for the new experimental development. The German investigators, W. Wundt, G. E. Müller, C. Stumpf, Ebbinghaus, and Munsterberg, have been prominent in introducing laboratory methods, and have determined such matters as the elementary laws of association and memory, and the perceptions of musical tones and their relations. The work of Goldschneider on "the muscular sense," of von Frey on the cutaneous sensations, are further examples of what is being done.

The difficult and extremely important line of investigation, first scientifically treated by Braid under the name "Hypnotism," has been greatly developed by the French school, especially by Charcot. The experimental investigation of "suggestion," and the pathology of dual consciousness and such exceptional conditions of the mind, has been greatly advanced by French observers.

The older work of Ferrier and Hitzig on the functions of the parts of the brain has been carried further by Goldz and Munk in Germany, and by Schäfer, Horsley, and Sherington in England.

The most important general advance seems to be the realisation that the mind of the human adult is a social product; that it can only be understood in relation with the special environment in which it develops, and with which it is in perpetual interaction. Professor Baldwin, of Princeton, has done important work on this subject. Closely allied is the study of what is called "the psychology of groups," the laws of mental action of the individual as modified by his membership of some form of society. French authors have done valuable work here.

These two developments of psychology are destined to provide the indispensable psychological basis for Social Science, and for the anthropological investigation of mental phenomena.

Hereafter, the well-ascertained laws of experimental psychology will undoubtedly furnish the necessary scientific basis of the art of education, and psychology will hold the same relation to that art as physiology does to the art of medicine and hygiene.

There can be little doubt, moreover, of the valuable interaction of the study of physical psychology and the theories of the origin of structural character by natural selection. The relation of the human mind to the mind of animals, and the gradual development of both, is a subject full of rich stores of new material, yielding conclusions of the highest importance, which has not yet been satisfactorily approached.

I am glad to be able to give wider publicity here to some conclusions which I communicated to the Jubilee volume of the Société de Biologie of Paris in 1899. I there discussed the significance of the great increase in the size of the cerebral hemispheres in recent, as compared with Eocene Mammals, and in Man as compared with Apes, and came to the conclusion that "the power of building up appropriate cerebral mechanism in response to individual experience," or what may be called "educability," is the quality which characterises the larger cerebrum, and is that which has led to its selection, survival, and further increase in volume. The bearing of this conception upon questions of fundamental importance in what has been called genetic psychology is sketched as follows:—

"The character which we describe as 'educability' can be transmitted; it is a congenital character. But the *results* of education can *not* be transmitted. In each generation they have to be acquired afresh. With increased 'educability' they are more readily acquired, and a larger variety of them. On the other hand, the nerve mechanisms of instinct are transmitted, and owe their inferiority as compared with the results of education to the very fact that they are *not* acquired by the individual in relation to his particular needs, but have arisen by selection of congenital variation in a long series of preceding generations."

"To a large extent the two series of brain-mechanisms, the 'instinctive' and the 'individually acquired,' are in opposition to one another. Congenital brain-mechanisms may prevent the education of the brain and the development of new mechanisms specially fitted to the special conditions of life. To the educable animal the less there is of specialised mechanism transmitted by heredity, the better. The loss of instinct is what permits and necessitates the education of the receptive brain."

"We are thus led to the view that it is hardly possible for a theory to be further from the truth than that expressed by George H. Lewes and adopted by George Romanes, namely, that instincts are due to 'lapsed' intelligence. The fact is that there is no community between the mechanisms of instinct and the mechanisms of intelligence, and that the latter are later in the history of the development of the brain than the former, and can only develop in proportion as the former become feeble and defective." (From the Jubilee volume of the Soc. de Biol. of Paris, 1899; reprinted in *Nature*, 1900, vol. lxi., pp. 624, 625).

*Darwinism*.—Under the title "Darwinism" it is convenient to designate the various work of biologists tending to establish, develop, or modify Mr. Darwin's great theory of the origin of species. In looking back over twenty-five years it seems to me that we must say that the conclusions of Darwin as to the origin of species by the survival of selected races in the struggle for existence are more firmly established than ever. And this because there have been many attempts to gravely tamper with essential parts of the fabric as he left it, and even to substitute conceptions for those which he endeavoured to establish, at variance with his conclusions. These attempts must, I think, be considered as having failed. A great deal of valuable work has been done in consequence; for honest criticism, based on observation and experiment, leads to further investigation, and is the legitimate and natural mode of increase of scientific knowledge. Amongst the attempts to seriously modify Darwin's doctrine may be cited that to

assign a great and leading importance to Lamarck's theory as to the transmission by inheritance of newly "acquired" characters, due chiefly to American palæontologists and to the venerated defender of such views, who has now closed his long life of great work, Mr. Herbert Spencer; that to attribute leading importance to the action of physiological congruity and incongruity in selective breeding, which was put forward by another able writer and naturalist who has now passed from among us, Dr. George Romanes; further, the views of de Vries as to discontinuity in the origin of new species, supported by the valuable work of Mr. Bateson on discontinuous variation; and, lastly, the attempt to assign a great and general importance to the facts ascertained many years ago by the Abbé Mendel as to the cross-breeding of varieties and the frequent production (in regard to certain characters in certain cases) of pure strains rather than of breeds combining the characters of both parents. On the other hand, we have the splendid series of observations and writings of August Weismann, who has, in the opinion of the majority of those who study this subject, rendered the Lamarckian theory of the origin and transmission of new characters altogether untenable, and has, besides, furnished a most instructive, if not finally conclusive, theory or mechanical scheme of the phenomena of Heredity in his book "The Germ-plasm." Professor Karl Pearson and the late Professor Weldon—the latter so early in life and so recently lost to us—have, with the finest courage and enthusiasm in the face of an enormous and difficult task, determined to bring the facts of variation and heredity into the solid form of statistical statement, and have organised, and largely advanced in, this branch of investigation which they have termed "Biometrics." Many naturalists throughout the world have made it the main object of their collecting and breeding of insects, birds, and plants, to test Darwin's generalisations, and to expand the work of Wallace in the same direction. A delightful fact in this survey is that we find Mr. Alfred Russel Wallace (who fifty years ago conceived the same theory as that more fully stated by Darwin) actively working and publishing some of the most convincing and valuable works on Darwinism. He is still alive, and not merely well, but pursuing his work with vigour and ability. It was chiefly through his researches on insects in South America and the Malay Islands that Mr. Wallace was led to the Darwinian theory, and there is no doubt that the study of insects, especially of butterflies, is still one of the most prolific fields in which new facts can be gathered in support of Darwin and new views on the subject tested. Prominent amongst naturalists in this line of research has been, and is, Edward Poulton of Oxford, who has handed on to the study of entomology throughout the world the impetus of the Darwinian theory. I must here also name a writer who, though unknown in our laboratories and museums, seems to me to have rendered very valuable service in later years to the testing of Darwin's doctrines and to the bringing of a great class of organic phenomena within the cognisance of those naturalists who are especially occupied with the problems of Variation and Heredity. I mean Dr. Archdall Reid, who has with keen logic made use of the immense accumulation of material which is in the hands of medical men, and has pointed out the urgent importance of increased use by Darwinian investigators of the facts as to the variation and heredity of that unique animal, man, unique in his abundance, his reproductive activity, and his power of assisting his investigator by his own record. There are more observations about the variation and heredity of man and the conditions attendant upon individual instances than with regard to any other animal Medical men need only to grasp clearly the questions at present under discussion in order to be able to furnish with ease data absolutely invaluable in quantity and quality. Dr. Archdall Reid has in two original books full of insight and new suggestions, the "Present Evolution of Man" and "Principles of Heredity," shown a new path for investigators to follow.

The attempt to resuscitate Lamarck's views on the inheritance of acquired* characters has been met not only by the demand for the production of experimental proof that such inheritance takes place, which has never been produced, but on Weismann's part by a demonstration that the reproductive cells of organisms are developed and set aside from the rest of the tissues at so early a period that it is extremely improbable that changes brought about in those other tissues by unaccustomed incident forces can be communicated to the germ-cells so as to make their appearance in the offspring by heredity. Apart from this, I have drawn attention to the fact that Lamarck's first and second laws (as he terms them) of heredity are contradictory the one of the other, and therefore may be dismissed. In 1894 I wrote:—

"Normal conditions of environment have for many thousands of generations moulded the individuals of a given species of organism, and determined as each individual developed and grew "responsive" quantities in its parts (characters); yet, as Lamarck tells us, and as we know, there is in every individual born a potentiality which has *not* been extinguished. Change the normal conditions of the species in the case of a young individual taken to-day from the site where for thousands of generations its ancestors have responded in a perfectly defined way to the normal and defined conditions of environment; reduce the daily or the seasonal amount of solar radiation to which the individual is exposed; or remove the aqueous vapour from the atmosphere; or alter the chemical composition of the pabulum accessible; or force the individual to previously unaccustomed muscular effort or to new pressures and strains; and (as Lamarck bids us observe), in spite of all the long-continued response to the earlier normal specific conditions, the innate congenital potentiality shows itself. The individual under the new quantities of environing agencies shows *new* responsive quantities in those parts of its structure concerned, new or *acquired* characters.

"So far, so good. What Lamarck next asks us to accept, as his 'second law,' seems not only to lack the support of experimental proof, but to be inconsistent with what has just preceded it. The new character which is *ex hypothesi*, as was the old character (length, breadth, weight of a part) which it has replaced—a response to environment, a particular moulding or manipulation by incident forces of the potential congenital quality of the race—is, according to Lamarck, all of a sudden raised to extraordinary powers. The new or freshly acquired character is declared by Lamarck and his adherents to be capable of transmission by generation; that is to say, it alters the potential character of the species. It is no longer a merely responsive or reactive character, determined quantitatively by quantitative conditions of the environment, but becomes fixed and incorporated in the potential of the race, so as to persist when other quantitative external conditions are substituted for those which originally determined it. In opposition to Lamarck, one must urge, in the first place, that this thing has never been shown experimentally to occur; and in the second place, that there is no ground for holding its occurrence to be probable, but, on the contrary, strong reason for holding it to be improbable. Since the old character (length, breadth, weight) had not become fixed and congenital after many thousands of successive generations of individuals had developed it in response to environment, but gave place to a new character when new conditions operated on an individual (Lamarck's first law), why should we suppose that the new character is likely to become fixed after a much shorter time of responsive existence, or to escape the operation of the first law? Clearly there is no reason (so far as Lamarck's statement goes) for any such supposition, and the two so-called laws of Lamarck are at variance with one another."

In its most condensed form my argument has been stated thus by Professor Poulton:—Lamarck's "first law assumes that a past history of indefinite duration is powerless to

* I use the term "acquired" without prejudice in the sense given to that word by Lamarck himself.

reate a bias by which the present can be controlled; while the second assumes that the brief history of the present can readily raise a bias to control the future" (*Nature*, 1894, vol. li., p. 127).

An important light is thrown on some facts which seem at first sight to favour the Lamarckian hypothesis by the consideration that, though an "acquired" character is not transmitted to offspring as the consequence of the action of external agencies determining the "acquirement," yet the tendency to react exhibited by the parent *is* transmitted, and if the tendency is exceptionally great a false suggestion of a Lamarckian inheritance can readily result. This inheritance of "variation in tendencies to react" has a wide application, and has led me to coin the word "educability" as mentioned in the section of this address on Psychology.

The principle of physiological selection advocated by Dr. Romanes does not seem to have caused much discussion, and has been unduly neglected by subsequent writers. It was ingenious, and was based on some interesting observations, but has failed to gain support.

The observations of de Vries—showing that in cultivated varieties of plants a new form will sometimes assert itself suddenly, and attain a certain period of dominance, though not having been gradually brought into existence by a slow process of selection—have been considered by him, and by a good many other naturalists, as indicating the way in which new species arise in Nature. The suggestion is a valuable one if not very novel, but a great deal of observation will have to be made before it can be admitted as really having a wide bearing upon the origin of species. The same is true of those interesting observations which were first made by Mendel, and have been resuscitated and extended with great labour and ingenuity by recent workers, especially in this country by Bateson and his pupils. If it should prove to be true that varieties when crossed do not, in the course of eventual inter-breeding, produce intermediate forms as hybrids, but that characters are either dominant or recessive, and that breeds result having pure unmixed characters—we should, in proportion as the Mendelian law is shown to apply to all tissues and organs and to a majority of organisms, have before us a very important and determining principle in all that relates to heredity and variation. It remains, however, to be shown how far the Mendelian phenomenon is general. And it is, of course, admitted on all sides that, even were the Mendelian phenomenon general and raised to the rank of a law of heredity, it would not be subversive of Mr. Darwin's generalisations, but probably tend to the more ready application of them to the explanation of many difficult cases of the structure and distribution of organisms.

Two general principles which Mr. Darwin fully recognised appear to me to deserve more consideration and more general application to the history of species than he had time to give to them, or than his followers have accorded to them. The first is the great principle of "correlation of variation," from which it follows that, whilst natural selection may be favouring some small and obscure change in an unseen group of cells—such as digestive, pigmentary or nervous cells, and that change a change of selective value—there may be, indeed often is, as we know, a correlated or accompanying change in a physiologically related part of far greater magnitude and prominence to the eye of the human onlooker. This accompanying or correlated character has no selective value, is not an adaptation—is, in fact, a necessary but useless by-product. A list of a few cases of this kind was given by Darwin, but it is most desirable that more should be established. For they enable us to understand how it is that specific characters, those seen and noted on the surface by systematists, are not in most cases adaptations of selective value. They also open a wide vista of incipient and useless developments which may suddenly, in their turn, be seized upon by ever watchful natural selection and raised to a high pitch of growth and function.

The second, somewhat but by no means altogether neglected, principle is that a good deal of the important variation in both plants and animals is not the variation of a minute part or confined to one organ, but has really an inner physiological basis, and may be a variation of a whole organic system or of a whole tissue expressing itself at several points and in several shapes. In fact, we should perhaps more generally conceive of variation as not so much the accomplishment and presentation of one little mark or difference in weight, length, or colour, as the expression of a *tendency to vary* in a given tissue or organ in a particular way. Thus we are prepared for the rapid extension and dominance of the variation if once it is favoured by selective breeding. It seems to me that such cases as the complete disappearance of scales from the integument of some osseous fishes, or the possible retention of three or four scales out of some hundreds present in nearly allied forms, favour this mode of conceiving of variation. So also does the marked tendency to produce membranous expansions of the integument in the bats, not only between the digits and from the axilla, but from the ears and different regions of the face. Of course, the alternative hairy or smooth condition of the integuments both in plants and animals is a familiar instance in which a tendency extending over a large area is recognised as that which constitutes the variation. In smooth or hairy varieties we do not postulate an individual development of hairs subjected one by one to selection and survival or repression.

*Disease.*—The study of the physiology of unhealthy, injured, or diseased organisms is called pathology. It necessarily has an immense area of observation, and is of transcending interest to mankind who do not accept their diseases unresistingly and die as animals do, so purifying their race, but incessantly combat and fight disease, producing new and terrible forms of it, by their wilful interference with the earlier rule of Nature.

Our knowledge of disease has been enormously advanced in the last quarter of a century, and in an important degree our power of arresting it, by two great lines of study going on side by side, and originated, not by medical men nor physiologists in the narrow technical sense, but by naturalists, a botanist, and a zoologist. Ferdinand Cohn, Professor of Botany in Breslau, by his own researches and by personal training in his laboratory, gave to Robert Koch the start on his distinguished career as a bacteriologist. It is to Metschnikoff the zoologist and embryologist that we owe the doctrine of phagocytosis and the consequent theory of immunity now so widely accepted.

We must not forget that in this same period much of the immortal work of Pasteur on hydrophobia, of Behring and Roux on diphtheria, and of Ehrlich and many others to whom the eternal gratitude of mankind is due, has been going on. It is only some fifteen years since Calmette showed that if cobra poison were introduced into the blood of a horse in less quantity than would cause death, the horse would tolerate with little disturbance after ten days a full dose, and then day after day an increasing dose, until the horse without any inconvenience received an injection of cobra poison large enough to kill thirty horses of its size. Some of the horse's blood being now withdrawn was found to contain a very active antidote to cobra poison—what is called an antitoxin. The procedure and preparation of the antitoxin is practically the same as that previously adopted by Behring in the preparation of the antitoxin of diphtheria poison. Animals treated with injections of these antitoxins are immune to the poison itself when subsequently injected with it, or if already suffering from the poison (as, for instance, by snake-bite), are readily shown by experiment to be rapidly cured by the injection of the appropriate antitoxin. This is, as all will admit, an intensely interesting bit of biology. The explanation of the formation of the antitoxin in the blood and its mode of antagonising the poison is not easy. It seems that the antitoxin is undoubtedly formed from the corresponding toxin or poison, and that the antagonism can be best understood as a chemical reaction by which the

complex molecule of the poison is upset, or effectively modified.

The remarkable development of Metschnikoff's doctrine of phagocytosis during the past quarter of a century is certainly one of the characteristic features of the activity of biological science in that period. At first ridiculed as "Metschnikoffism," it has now won the support of its former adversaries.

For a long time the ideal of hygienists has been to preserve man from all contact with the germs of infection, to destroy them, and destroy the animals conveying them, such as rats, mosquitoes, and other flies. But it has now been borne in upon us that, useful as such attempts are, and great as is the improvement in human conditions which can thus be effected, yet we cannot hope for any really complete or satisfactory realisation of the ideal of escape from contact with infective germs. The task is beyond human powers. The conviction has now been arrived at that, whilst we must take every precaution to diminish infection, yet our ultimate safety must come from within—namely, from the activity, the trained, stimulated, and carefully guarded activity of these wonderful colourless amœba-like corpuscles whose use was so long unrecognised, but has now been made clear by the patiently continued experiments and arguments of Metschnikoff, who has named them "phagocytes." The doctrine of the activity and immense importance of these corpuscles of the living body which form part of the all-pervading connective tissues and float also in the blood, is in its nature and inception opposed to what are called the "humoral" and "vitalistic" theories of resistance to infection. Of this kind were the beliefs that the *liquids* of the living body have an inherent and somewhat vague power of resisting infective germs, and even that the mere living quality of the tissues was in some unknown way antagonistic to foreign intrusive disease-germs.

The first eighteen years of Metschnikoff's career, after his under-graduate course, were devoted to zoological and embryological investigations. He discovered many important facts, such as the alternation of generations in the parasitic worm of the frog's lung—*Ascaris nigrovenosa*—and the history of the growth from the egg of sponges and medusæ. In these latter researches he came into contact with the wonderfully active cells, or living corpuscles, which in many low forms of life can be seen by transparency in the living animal. He saw that these corpuscles (as was indeed already known) resemble the well-known amœba, and can take into their soft substance (protoplasm) at all parts of their surface any minute particles and digest them, thus destroying them. In a transparent water-flea Metschnikoff saw these amœba-like, colourless, floating blood-corpuscles swallowing and digesting the spores of a parasitic fungus which had attacked the water-fleas, and was causing their death. He came to the conclusion that this is the chief, if not the whole, value of these corpuscles in higher as well as lower animals, in all of which they are very abundant. It was known that when a wound bringing in foreign matter is inflicted on a vertebrate animal the blood-vessels become gorged in the neighbourhood and the colourless corpuscles escape through the walls of the vessels in crowds. Their business in so doing, Metschnikoff showed, is to eat up the foreign matter, and also to eat up and remove the dead, wounded tissue. He therefore called these white or colourless corpuscles "phagocytes," the eater-cells, and in his beautiful book on Inflammation, published twenty years ago, proved the extreme importance of their activity. At the same time he had shown that they eat up intrusive bacteria and other germs; and his work for the last twenty years has mainly consisted in demonstrating that they are the chief, and probably the only, agents at work in either ridding the human body of an attack of disease-causing germs or in warding off even the commencement of an attack, so that the man or animal in which they are fully efficient is "immune"—that is to say, cannot be effectively attacked by disease-germs.

Disease-germs, bacteria, or protozoa produce poisons which sometimes are too much for the phagocytes, poisoning them and so getting the upper hand. But, as Metschnikoff showed, the training of the phagocytes by weak doses of the poison of the disease-germ, or by weakened cultures of the disease-germ itself, brings about a power of resistance in the phagocytes to the germ's poison, and thus makes them capable of attacking the germs and keeping them at bay. Hence the value of inoculations.

The discussion and experiments arising from Metschnikoff's demonstrations have led to the discovery of the production by the phagocytes of certain exudations from their substance which have a most important effect in weakening the resistance of the intrusive bacteria and rendering them easy prey for the phagocyte. These are called "sensitisers," and have been largely studied. They may be introduced artificially into the blood and tissues so as to facilitate the work of the phagocytes, and no doubt it is a valuable remedial measure to make use of such sensitisers as a treatment. Dr. Wright considers that such sensitisers are formed in the blood and tissues independently of the phagocytes, and has called them "opsonins," under which name he has made most valuable application of the method of injecting them into the body so as to facilitate the work of the phagocytes in devouring the hostile bacteria of various diseases. Each kind of disease-producing microbe has its own sensitiser or opsonin; hence there has been much careful research and experiment required in order to bring the discovery to practical use. Metschnikoff himself holds and quotes experiments to show that the "opsonins" are actually produced by the phagocytes themselves. That this should be so is in accordance with some striking zoological facts, as I pointed out nearly twenty years ago. For the lowest multicellular animals provided with a digestive sac or gut, such as the polyps, have that sac lined by digestive cells which have the same amœboid character as "phagocytes," and actually digest to a large extent by swallowing or taking into their individual protoplasm raw particles of food. Such particles are enclosed in a temporary cavity, or vacuole, into which the cell-protoplasm secretes digestive ferment and other chemical agents. Now there is no doubt that such digestive vacuoles may burst and so pour out into the polyp's stomach a digestive juice which will act on food particles outside the substance of the cells, and thus by the substitution of this process of outpouring of the secretion for that of ingestion of food particles into the cells we get the usual form of digestion by juices secreted into a digestive cavity. Now this being certainly the case in regard to the history of the original phagocytes lining the polyp's gut, it does not seem at all unlikely, but on the contrary in a higher degree probable, that the phagocytes of the blood and tissues should behave in the same way, and pour out sensitisers and opsonins to paralyse and prepare their bacterial food. And the experiments of Metschnikoff's pupils and followers show that this is undoubtedly the case. Whether there is any great variety of, and difference between, "sensitisers" and "opsonins" is a matter which is still the subject of active experiment. Metschnikoff's conclusion, as recently stated in regard to the whole progress of this subject, is that the phagocytes in our bodies should be stimulated in their activity in order successfully to fight the germs of infection. Alcohol, opium, and even quinine, hinder the phagocytic action; they should therefore be entirely eschewed or used only with great caution where their other and valuable properties are urgently needed. It appears that the injection of blood-serum into the tissues of animals causes an increase in the number and activity of the phagocytes, and thus an increase in their resistance towards pathogenic germs. Thus Durham (who was a pioneer in his observations on the curious phenomena of the "agglutination" of blood corpuscles in relation to disease) was led to suggest the injection of sera during surgical operations, and experiments recently quoted by Metschnikoff seem to show that the suggestion was well founded. Both German and French surgeons have employed the method with successful results, and the demon-

stration that an immense number of microbes are thus taken up and destroyed by the multiplication (due to their regular increase by cell division) of the phagocytes of the injected patient. After years of opposition bravely met in the pure scientific spirit of renewed experiment and demonstration, Metschnikoff is at last able to say that the foundation stone of the hygiene of the tissues—the thesis that our phagocytes are our arms of defence against infective germs—has been generally accepted.

Another feature of the progress of our knowledge of disease—as a scientific problem—is the recent recognition that minute animal parasites of that low degree of unicellular structure to which the name "Protozoa" is given, are the causes of serious and ravaging diseases, and that the minute algoid plants, the bacteria, are not alone in possession of this field of activity. It was Laveran—a French medical man—who, just about twenty-five years ago, discovered the minute animal organism in the red blood-corpuscles, which is the cause of malaria. Year by year ever since our knowledge of this terrible little parasite has increased. We now know many similar to, but not identical with it, living in the blood of birds, reptiles, and frogs.

It is the great merit of Major Ross, formerly of the Indian Army Medical Staff, to have discovered, by most patient and persevering experiment, that the malaria parasite passes a part of its life in the spot-winged gnat or mosquito (*Anopheles*), not, as he had first supposed, in the common gnat or mosquito (*Culex*), and that if we can get rid of spot-winged mosquitoes or avoid their attentions, or even only prevent them from sucking the blood of malarial patients, we can lessen, or even abolish, malaria.

This great discovery was followed by another as to the production of the deadly "Nagana" horse and cattle disease in South Africa by a screw-like, minute animal parasite, the *Trypanosoma Drucei*. The Tsetze fly, which was already known in some way to produce this disease, was found by Colonel David Bruce to do so by conveying by its bite the Trypanosoma from wild big game animals, to the domesticated horses and cattle of the colonists. The discovery of the parasite and its relation to the fly and the disease was as beautiful a piece of scientific investigation as biologists have ever seen. A curious and very important fact was discovered by Bruce—namely, that the native big game (zebras, antelopes, and probably buffaloes), are *tolerant* of the parasite. The Trypanosoma grows and multiplies in their blood, but does not kill them or even injure them. It is only the unaccustomed introduced animals from Europe which are poisoned by the chemical excreta of the Trypanosomes and die in consequence. Hence the wild creatures—brought into a condition of tolerance by natural selection and the dying out of those susceptible to the poison—form a sort of "reservoir" of deadly Trypanosomes for the Tsetze flies to carry into the blood of new-comers. The same phenomenon of "reservoir-hosts" (as I have elsewhere called them) has since been observed in the case of malaria; the children of the native blacks in Africa and in other malarious regions are *tolerant* of the malarial parasite, as many as 80 per cent of children under ten being found to be infected, and yet not suffering from the poison. This is not the same thing as the immunity which consists in *repulsion* or *destruction* of the parasite.

The Trypanosomes have acquired a terrible notoriety within the last four yeas, since another species, also carried by a Tsetze fly of another species, has been discovered by Castellani in cases of sleeping sickness in Uganda, and demonstrated by Colonel Bruce to be the cause of that awful disease. Over 200,000 natives of Uganda have died from it within the last five years. It is incurable, and, sad to relate, not only a certain number of European employés have succumbed to it in tropical Africa, but a brave young officer of the Army Medical Corps, Lieutenant Tulloch, has died from the disease acquired by him in the course of investigation of this disease and its possible cure, which he was carrying out, in association with other men of science, on the Victoria Nyanza Lake in Central Africa. Lieutenant Tulloch was sent out to this investigation by the Royal Society of London, and I will venture to ask you to join that body in sympathy for his friends, and admiration for him and the other courageous men who risk their lives in the endeavour to arrest disease.

Trypanosomes are now being recognised in the most diverse regions of the world as the cause of disease—new horse diseases in South America, in North Africa, in the Philippines and East India are all traced to peculiar species of Trypanosome. Other allied forms are responsible for Delhi-sore, and certain peculiar Indian fevers of man. A peculiar and ultra-minute parasite of the blood cells causes Texas fever, and various African fevers deadly to cattle. In all these cases, as also in that of plague, the knowledge of the carrier of the disease, often a mite or acarus—in that of plague the flea of the rat—is extremely important, as well as the knowledge of reservoir-hosts when such exist.

The zoologist thus comes into closer touch than ever with the profession of medicine, and the time has arrived when the professional students of disease fully admit that they must bring to their great and hopeful task of abolishing the diseases of man the fullest aid from every branch of biological science. I need not say how great is the contentment of those who have long worked at apparently useless branches of science, in the belief that all knowledge is good, to find that the science they have cultivated has become suddenly and urgently of the highest practical value.

I have not time to do more than mention here the effort that is being made by combined international research and co-operation to push further in our knowledge of phthisis and of cancer, with a view to their destruction. It is only since our last meeting at York that the parasite of Phthisis or Tubercle has been made known; we may hope that it will not be long before we have similar knowledge as to Cancer. Only eighteen months have elapsed since Fritz Schaudinn discovered the long-sought parasitic germ of Syphilis, the *Spirocheta pallida*. As I write these words the sad news of Schaudinn's death at the age of thirty-five comes to me from his family at Hamburg—an irreparable loss.

Let me finally state, in relation to this study of disease, what is the simple fact—namely, that if the people of Britain wish to make an end of infective and other diseases they must take every possible means to discover capable investigators, and employ them for this purpose. To do this far more money is required than is at present spent in that direction. It is necessary, if we are to do our utmost, to spend a thousand pounds of public money on this task where we now spend one pound. It would be reasonable and wise to expend ten million pounds a year of our revenues on the investigation and attempt to destroy disease. Actually, what is so spent is a mere nothing, a few thousands a year. Meanwhile our people are dying by thousands of preventable disease.

To be continued).

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**Non-existence of Phosphorus Trisulphide.**—R. Boulouch.—Several chemists refuse to regard phosphorus trisulphide, $P_2S_3$, as a definite compound, chiefly because its distillation gives products of different composition. Further, its mixed constitution appears to result from the fact that its fusion, which takes place a little below 200°, ought not to be total till over 300°. The author makes a series of investigations on the nature of this substance, and finds definitely that there do not exist any definite phosphorus sulphides having formulæ between $P_4S_3$ and $P_3S_5$, and, consequently, there can be no phosphorus trisulphide. He also states that $P_3S_5$ is not necessarily a definite compound.—*Comptes Rendus*, cxliii., No. 1,

# ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.

## York, 1906.

By Prof. WYNDHAM DUNSTAN, M.A., LL.D., F.R.S., F.C.S., President of the Section.

### Some Imperial Aspects of Applied Chemistry.

The President of the Chemical Section of the British Association must always have a large choice of subjects for his Address. He may attempt to review the chemical progress of the year, or to give an account of researches in that division of the science in which he is most interested. He may deal with the ever-recurring problems of education; or, again, he may draw attention to the importance of our science in one or other of its many relations to National and Imperial affairs. I have decided to adopt the last course, and to invite your attention at York, where several tropical products furnish the basis of important industries, to the intimate connection of our science with the problems that await solution in connection with the utilisation of the raw materials and economic products of our Colonies, and especially those of our tropical Possessions. There is a pressing need that the Imperial Government should recognise much more fully than it has hitherto done, and at least as fully as foreign Governments are already doing, the claims of scientific investigation to be regarded as the pioneer instrument of this work, and as the essential first step in the material and commercial development of our Possessions.

Although my remarks will be chiefly directed to the importance of chemistry in this connection, my plea will be more general. It is that the scientific method of experimental research should be systematically applied in each division of the sciences concerned. In the case of raw materials, however, whether vegetable or mineral, their commercial value must depend chiefly, if not entirely, upon their composition, and sooner or later the method of chemistry must therefore be applied.

In determining the value of the mineral resources of a country other specialists are also concerned, and the assistance of the geologist, the mineralogist, and eventually of the metallurgist may be required. Similarly with vegetable and agricultural products the services of the economic botanist and the entomologist will be needed. It will therefore be necessary for me in dealing with the subject as a whole to touch upon several aspects in which other sciences are concerned, and with which the science of chemistry must co-operate in attaining a practical end—namely, the material development of the countries concerned. I need make no apology for many allusions to scientific agriculture, for this subject is this year attached to this Section, and indeed the science of chemistry is of fundamental importance to agricultural practice both at home and in the tropics.

In the first place I must ask you to allow me to say a few words as to the very wide interests that are involved in the proper solution of the problem of colonial development.

It is all-important that the wage-earning community of this country should have an adequate supply of tea, coffee, cocoa, rice, tobacco, and other commodities, and that our manufacturers should be able to count upon a regular supply of cotton, jute, rubber, and other raw materials as far as possible under their own control. All these products are derived almost exclusively from the tropics, and experience shows that it is a great disadvantage to the manufacturer not to be able to exercise control in the direction of securing the regular production of these materials, and especially not to be able to avoid the great and sudden fluctuations in their price, which are often the result of financial speculation on the part of a foreign capitalist who has secured the control of the output of a foreign country.

The almost entire dependence of the great textile industries of Lancashire upon the cotton crop of the Southern States of America has placed this industry at the mercy of American speculators, whose tactics may lead, as in 1903, to such a rise in the price of the raw material as to render it imperative for the manufacturer to close his mills, and by throwing large numbers out of employment to bring poverty and misery to many thousands of people.

The great principle which must now necessarily guide our system of administration and expenditure in our tropical Colonies and Protectorates has as its purpose the utilisation of natural resources and the creation and development of native industries with the aid of European supervision and advice. Adequate supplies of produce, natural and agricultural, will thus be ensured to British manufacturers and consumers from territories within the administration of the British Crown. This principle of employing our "undeveloped estates" for the advantage of our manufacturers and consumers, and at the same time for the benefit of the natives who inhabit these countries, was put into action by Mr. Chamberlain during his long tenure of office as Secretary of State for the Colonies, and this recognition of a vitally important principle must always be associated with his name.

Excepting India and the self-governing Colonies, the Crown Colonies and Protectorates, for which alone the Imperial Government is directly responsible, include an area of about two and a-half million square miles and a population of about forty millions. The value of these possessions to us at the present time may be judged from the value of their import and export trade with the United Kingdom. The value of the exports of these countries in 1904 was estimated at about four and a-half million pounds sterling, and the imports from the United Kingdom at about twelve and a-half million pounds sterling. In gauging the importance to this country of the development of these Possessions, the export trade of which is only in its infancy, it should be remembered that the profits arising from the export as well as from the import trade are chiefly domiciled in this country, since practically the whole of this trade is in the hands of British merchants, and the entire profits, including those of shipping, &c., are therefore subject to our national system of taxation, and represent a very substantial annual contribution to the British Exchequer.

It is therefore only reasonable that a certain sum should be expended from British funds to aid the applications of science to the commercial development of these Possessions. Such an expenditure in the light of the facts to which I have drawn attention may be regarded as an investment with the certainty of a profitable return.

I have thought it necessary to give this brief account of the position of our still undeveloped Crown Colonies and Protectorates and the national importance to us of their systematic development before proceeding to the principal subject of this Address, which is to emphasize the aid which science in several of its branches can render to this work of development, and especially the science of chemistry, the capacities of which in this connection have so far not been sufficiently recognised.

The importance of utilising our own tropical Possessions as sources of the raw material required by the manufacturer is now generally recognised, and very considerable progress has been made in recent years. The tea produced in India and Ceylon has largely superseded the China tea formerly used in this country. Similarly, coffee is extensively grown in India, in the West Indies, and in several of our African Possessions. The jute cultivation in India has been very successful, and the demand for this fibre is so great that the question of its cultivation in our West African Colonies is now under consideration. Indiarubber, hitherto chiefly obtained from South America, is of increasing importance as a commercial article, and the South American tree has been introduced with success in Ceylon, the Straits Settlements, and the Federated Malay States, which are rapidly becoming important rubber-producing countries, whose produce is competing success-

fully with that of South America. The cultivation of cotton, hitherto principally carried on in the United States, is being vigorously proceeded with in India, the West Indies, and in West Africa, as well as in Egypt and the Sudan, and we may look forward in the future to these countries supplying the British manufacturer with a large proportion, if not the whole, of the cotton he requires.

There are, however, vast resources, both mineral and vegetable, in our Colonies and Protectorates which are awaiting development for an exact knowledge of their composition and properties, which can only be ascertained by scientific means and chiefly through chemical investigation, whilst the British manufacturer is in need of increased and better supplies of the raw materials on which his industrial activity depends. This demand for increased supplies now affects nearly every industry in this country. Rubber and fibres are well-known examples; oils and fats for the manufacture of soap and perfumes; and tanning materials, as well as numerous minerals, are other instances in which our manufacturers are at present anxious to discover new sources of supply. These sources can only be discovered and their value ascertained by properly directed scientific investigations.

We have heard much recently respecting the assistance which science can bring to the maintenance and development of the industrial efficiency of this country, and the Imperial Government is being urged to give its help especially by providing increased facilities for the education of scientific men, competent to aid the manufacturers of this country in improving their methods and processes. In this work the science of chemistry is one of the most important. There is scarcely an industry to which it is not able to render immense service. Within recent years this fact has slowly gained recognition, and the principle of State assistance to industry is virtually admitted, both in respect of education and of research. The most recent examples of a recognition of the principle are the grants made from the National Treasury to the new Technological College at South Kensington and to the National Physical Laboratory.

Not less important than the service which science can render to existing industries and their extension is that which it can contribute to the Imperial problem of ascertaining and rendering available for the manufacturer the vast undeveloped resources of our own Possessions. Our own experience and the example of other countries have shown that such work cannot be systematically carried on by private enterprise. Upon its successful accomplishment depends, not only the unrestricted supply of the necessary raw materials for which the manufacturer looks in increasing quantity, but also the prosperity of the country which produces these materials. This success can only be brought about by a combined effort on the part of the manufacturer and of the Government. The manufacturer can provide information as to the materials he needs. The preliminary work of discovering suitable material by scientific means, as several foreign Governments have already recognised, must be endowed, directed, and carried on with Imperial funds. It cannot be expected that private enterprise will take steps to explore the resources of little-known countries on the chance of a particular material being discovered, nor can the work, as a rule, be successfully done by this means. Experience shows that the most effective manner of promoting the commercial development of a new country is for the Government to carry out systematically with its own officers the preliminary work of exploration and examination of the natural resources, with the aid of such technical advice as may be necessary from manufacturers and users, and then, having established the fact that particular products of value can be found or cultivated in a given country, to leave commercial enterprise to do the rest. By action on these lines immense progress is being made in French, German, and Dutch Possessions, whilst the United States Government has taken similar action with the Philippines. In our own case, where this work exists it is in most cases in a more or less embryonic condition, and lacks the organisation which is necessary for success.

In many of our Crown Colonies and Protectorates there already exist, or are in the process of organisation, agricultural and other scientific departments, many of which include officers who are engaged in the work of exploring and developing the vegetable resources of these countries especially by experimental planting. Chemists are attached to some, but not to all of these departments. In the West Indies the valuable work accomplished by Professor Harrison, Mr. Francis Watts, Professor Albuquerque, Professor Carmody, and Mr. Cousins is well known, and illustrates the great services which the science of chemistry may render, not only to tropical agriculture, but to every branch of economic development. It is clearly desirable that at least one scientific department should be attached to the Government of each of the principal Crown Colonies and Protectorates. As a rule, it is convenient that this should be an agricultural department with the services of a scientific chemist at its disposal. In a tropical climate, and with limited appliances at his command, it must be admitted that a chemist is severely handicapped, and, as a rule, he cannot be expected at first to be able to do much beyond the comparatively simple and preliminary work, chiefly analytical, which, however, in a little known country is of the greatest importance to an agricultural department. In addition, he would have to deal with the composition of natural products of all kinds, both vegetable and mineral, as well as with the improvement of native industries. If the chemist is able to refer complicated or special investigations to a central department at home, and is provided with assistance in the routine work, he would be in a position to undertake the scientific investigation of a selection from the numerous problems with which a chemist will be confronted.

A chemist working in the spirit of an investigator will be able to render special services to the cause of tropical agriculture, and it is therefore of importance that in future the men appointed to these posts should be chosen as far as possible on account of the promise they have shown as investigators. The determination of the constituents of little known indigenous plants as the first step towards ascertaining their economic value is another department of work which cannot be carried out without a chemist, and the same applies to the examination of poisonous plants, and also of minerals, in addition to the determination of the composition of foods and feeding stuffs.

Tropical agriculture is a subject which is now of the first importance, especially in those countries in which our policy is to depend on a native population for the actual cultivation of the soil. We have two functions to perform in our position as supervisors; the one is to ascertain the nature and capabilities of the soil by actual experiment, for which well-organised experimental stations are a necessary part of every agricultural department; the other duty is to convey to the natives, chiefly by means of demonstration, the results of this experimental work, so that they may be persuaded to make it a part of their agricultural practice.

Work on these lines is being done under Government auspices in the French and German Colonies, and I may allude to the French successes in Algeria, in Senegal, and in the Sudan, and to the advances made by Germany in East Africa. These achievements are mainly due to a policy of continuous scientific work on agricultural lines. We shall have the privilege of hearing from Dr. Greshoff, the eminent director of the Colonial Museum at Haarlem, an account of the chemical investigations which are being carried out in connection with Java and the Dutch East Indies.

In many of our own Colonies and Protectorates active agricultural departments, equipped with the means of experimental working, are only now in process of organisation. One of the most recently organised of these is that of the Transvaal, which, at Lord Milner's initiation, has been completely equipped on the lines of that model for all

such effort, the agricultural department of the United States. This department has as its chief chemist Mr. Herbert Inglis, of the Yorkshire College, now the University of Leeds.

If we are to compete successfully with foreign countries it is necessary that the position of science in relation to tropical agriculture should be definitely recognised. The days when a botanical garden served the purpose of an entire scientific establishment in a Colony have passed away, and we now require, in order that a proper return should be obtained, and the natives assisted in their agricultural practice, a scientific department with a proper complement of specially trained officers, including a consulting chemist, other specialists being added to the staff as the requirements arise. These officers should be remunerated on a scale likely to attract some of the best educated men from this country, which is at present far from being the case.

It would be out of place to discuss here the detailed organisations of these scientific departments. I merely desire to urge the necessity of their functions being extended, and to their receiving adequate financial support.

It is important that the scientific work which is being accomplished by these various departments should be brought to a focus, and that the results obtained in one Colony should be available for the information of the departments in other Colonies. The work of all such establishments requires to be unified by co-operation with a Central Department which can extend the investigations conducted in the Colonies, carry out investigations and inquiries which cannot be undertaken on the spot, maintain the necessary touch with the manufacturers, and co-ordinate the work undertaken and the results obtained in each of the separate Colonial establishments and systematically collate it, so that each may be aware of the results that are being obtained in other countries. In our African Possessions at present the same investigations and inquiries have to be conducted independently, and often without the knowledge that the problem in question has been already solved.

Another increasingly urgent duty of the Central Department is to inform the Colonial establishments of the results of the work which is being conducted in foreign countries, and of the progress which is being made in the utilisation of raw materials all over the world, and to bring to their notice the constantly changing requirements of the manufacturers and users of raw materials.

So far as botany is concerned, this co-ordination has been to a large extent effected through the agency of the Royal Gardens, Kew, which is in touch, through the Colonial Office, with all the botanical gardens in the Crown Colonies and Protectorates. In chemistry, as well as in certain other subjects, these duties have been performed in recent years by the Scientific and Technical Department of the Imperial Institute, which is now working in co-operation, not only with the Governments of the Crown Colonies and Protectorates, but also with those of several of the self-governing Colonies, and also with the Scientific Departments, which have been brought into existence in India, where at last the importance of scientific agriculture is receiving due recognition from the Government.

So little has hitherto been done in this direction that the number of problems requiring attention is exceedingly large; and even with a specially trained staff of workers and extensive laboratories, such as now exist at the Imperial Institute, it becomes necessary to select as the principal subjects for investigation those which are regarded by the Governments of the countries concerned as of the most practical importance and in which the British manufacturer is at the moment most concerned. There must therefore remain a large number of materials of unknown composition, and of problems of purely scientific interest which offer an attractive field for the chemical investigator. Already steps have been taken to provide for the investigation of these subjects by scientific men who are willing to undertake them in communication with the Institute. For example, Mr. A. G. Perkin, F.R.S., has been furnished with material which has led to the identification and determination of the constitution of the colouring matters of a number of plants which are employed as dyes in India and the Colonies. Professor A. H. Church, F.R.S., has determined the composition of many new or little known food grains. Dr. Crossley, Mr. Le Sueur, and Dr. Lewkowitsch have examined the constituents of a large number of fats and oils furnished by seeds of Indian and African origin. Dr. W. J. Russell, F.R.S., has been furnished with selected materials for examination in connection with his interesting investigations of those substances which affect the photographic plate in the dark, whilst the Hon. R. J. Strutt, F.R.S., has investigated the radio-activity of a number of new or little known minerals containing rare earths. Last year over five hundred different materials and problems were submitted from the Colonies and India for investigation to the Scientific Department of the Imperial Institute, and each year there must remain an increasing number of interesting subjects which cannot be included in the Department's annual programme of work. Many of these would furnish excellent subjects for chemical research by advanced students in connection with the universities and technical colleges throughout the country. It is nearly always possible to arrange to furnish the necessary material for any competent worker to deal with. Next year a list of such subjects awaiting investigation will be available at the Imperial Institute for those in search of subjects for chemical research.

Whilst the investigation of some of these subjects may at once produce results of scientific value, many of them present difficulties in their investigation which are far more serious than those which attend the usual synthetical work in organic chemistry. I do not know of any more profitable experience for the advanced student who is already familiar with the principles of organic chemistry and of laboratory practice than the separation in the pure state of the chemical constituents of a plant and the determination of their chemical constitution. In inorganic chemistry the examination of a new mineral furnishes similar experience.

In carrying out research of the kind I am advocating, the chemical investigator will have the additional advantage of knowing that the scientific results he obtains will contribute to the knowledge of the resources of the British Empire, and possibly be the means of laying the foundations of new industries.

I need hardly remind chemists that some of the most important discoveries in our science, and many of those which have had the most profound influence on the development of chemical theory, have arisen from the examination of the constituents of raw materials. The discovery of morphia in opium led to the recognition of the new class of alkaloids; the discovery of amygdalin in the bitter almond of the new group of glucosides; the investigation by Liebig and Wöhler of the chemical properties and composition of the essential oil of the bitter almond was largely instrumental in laying the foundations of modern organic chemistry; whilst it was during the examination of the constituents of bran that Fownes was led to the discovery of furfurol and the subsequent recognition of a new type of organic compound. In more recent times, the examination of the constituents of oil of turpentine and various essential oils yielded by different plants has been the means of elucidating the chemical theory of the great group of terpenes, and latterly Harries' investigation of caoutchouc has led to the discovery of the ozonides, which seem likely to be of much importance as a new means of determining the constitution of certain classes of organic compounds. Lastly, I may remind you that the discovery of helium might have been long delayed had not Professor Miers drawn Sir William Ramsay's attention to the so-called nitrogen furnished by the mineral cleveite.

(To be continued).

## NOTES OF A COURSE OF LECTURES ON THE OLD AND NEW CHEMISTRY.†

### II. Extracts from different Authors Relating to the New Chemistry.

By Prof. Sir JAMES DEWAR, F.R.S., &c.

(Concluded from p. 58).

*Later Phases of Chemical Progress.—Dewar.*

1. Faraday's Law of Electro-chemical Decomposition; Mechanical Equivalent of Heat (Joule, Mayer); Carnot's Theory of the Motive Power of Heat; Conservation of Energy (Joule, Mayer, and Helmholtz); Absolute Thermometric Scale and Measurement of Electro-Motive Forces (Kelvin); Thermal Effects of Fluids in Motion (Joule and Kelvin).

2. Avogadro distinction of Atoms and Molecules; Radical Theory; Organic Substitution; Organo-Metallic Bodies; Idea of Structure; Classification; Vegetable and Animal Chemistry; Analogy between Inorganic and Organic Chemistry (Work of Wöhler, Liebig, Dumas, Laurent, Gerhardt).

3. Addition of Twenty-five new Elements; New Atomic Weights; Atomicity of the Elements; Tetra Atomicity of Carbon Basis of Organic Chemistry; Periodic Law of the Distribution of Atomic Weights (Newlands, Mendeleeff); Prediction and Discovery of Missing Elements (Mendeleeff); Correction of Atomic Weights; Extension of the Law to the Physical Properties of the Elements and Compounds.

4. Dissociation and the Law of Chemical Equilibrium; Density of Vapours and High Temperatures (Deville); Application of Thermo-dynamical Laws to Chemical Interaction; Measurement of the Energy of Reactions; Thermal Chemistry; Temperature of Flame; Pressure of Gaseous Re-actions; Study of Explosives; Phase Rule (Gibbs); Mass in Relation to Chemical Action.

5. Spectrum Analysis (Bunsen and Kirchoff); Discovery of New Elements; Solar and Stellar Chemistry; Spectra of the Elements; Tables of Wave Lengths (Angstrom and Thalen); Ultra Violet and Infra Red Spectra; Universal Distribution of the Earth Elements; Spectroscopic and Chemical Analysis of Meteorites; The Laws of Series in Line and Band Spectra; Photographic and Phosphorescent Actions.

6. Liquid and Gaseous Diffusion; Occlusion and the Nature of Crystalloids and Colloids (Graham); Solid Solution; Eutectic Mixtures; Constitution of Alloys; Continuity of the Gaseous and Liquid States of Matter (Andrews); Generalised Equation of the Gaseous Laws (Van der Waals).

7. Theory of Solution; Osmotic Pressure; Electrolytic Dissociation; Electric Conductivity; Ionic Hypothesis; Atomic Electricity; Solution Molecular Weights; Number of Molecules entering into a Reaction; Velocity of Chemical Change (Work of Raoult, Arrhenius, Van't Hoff, Oswald.

8. Development of Organic Synthesis; Benzene Ring (Kekulé); Position Theory; Coal Tar Colours; Artificial Formation of Sugars; Pyridine Ring; Alkaloids like Conia and Nicotin; Colouring Matters like Alizarin and Indigo; Albumen Derivatives like the Polypeptides.

9. Fermentation (Pasteur); Bacteria, Enzymes, Toxins, and Antitoxins; Zymase; Dextra and Lævo Rotation in Organic Bodies; The Asymmetric Carbon Atom; Stereo-Chemistry.

10. Liquid Air and the Command of Low Temperatures; Solid Hydrogen; Nadir of steady Temperature of - 258° C.; Charcoal at Low Temperatures as Agent of Research; Properties of Matter near the Zero of Absolute Temperature; Hydrogen not a Metal; Electric Furnace; Metallic Carbides and Hydrides; Synthesis of Hydrocarbons; Industrial Production of Cyanamide and Nitric Acid; Industrial Electrolysis of Fuse Salts; Metals as Fuel; Artificial Minerals.

11. Fourth state of Matter (Crookes); Electric Discharge in High Vacua; Röntgen Radiation; Radio-Activity of Uranium (Becquerel); Isolation of Polonium and Radium (Professor and Madame Curie); Heat Evolution of Radium; Rate of Energy Emission in Radio-Active Bodies a Constant; Luminosity of Radium; Emanations of Radium; Electrical, Photographic, and Fluorescent Effects; Atomic Disintegration; Seven Transformation Products of Radium; Helium Constituent of Decomposition Products of the Radium Atom; Thorium and Actinium Emanations; Emanation in Active Gases.

12. Electrons; Corpuscles; Structure of the Atom; Electrical Basis of Matter.

*The Future of Chemistry.*

"The most important uses of natural objects are not those which offer themselves to us most obviously. The chief use of the moon for man's immediate purposes remained unknown to him for five thousand years from his creation. And, since it cannot but be that innumerable and most important uses remain to be discovered among the materials and objects already known to us, as well as among those which the progress of science must hereafter disclose, we may hence conceive a well-grounded expectation, not only of constant increase in the physical resources of mankind, and the consequent improvement of their condition, but of continual accessions to our power of penetrating into the arcana of nature, and becoming acquainted with her highest laws." (Herschel).

* Delivered at the Royal Institution, May 26th, 1906.

## CORRESPONDENCE.

ON THE

### CONDENSATION PRODUCTS OF α-NAPHTHOL AND BENZOPHENONE CHLORIDE.

*To the Editor of the Chemical News.*

Sir,—The products obtained by the condensation of benzophenone chloride with α-naphthol, mentioned by A. G. Shrimpton, B.Sc., in the Chemical News of July 13th (vol. xciv., p. 13), were described in a paper entitled "Condensation of Benzophenone Chloride with α- and β-Naphthols" in the *Trans. Chem. Soc.*, 1906, lxxxix., 771).—I am, &c.,

G. W. Clough.

## CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxliii., No. 1, July 2, 1906.

**Action of Sulphuretted Hydrogen on certain Metallic and Metalloidal Oxides. Application to Volcanic Phenomena and Thermal Waters.**—Armand Gautier.—The author investigates the action of sulphuretted hydrogen in presence of $Fe_2O_3$, $Al_2O_3$, $H_2O$, CO, $CO_2$, $SiO_2$, &c., at the high temperatures of the interior of the earth.

**Certain Synthetic Reactions of Pinacoline.**—Louis Henry.—Hitherto pinacoline has never been investigated in its capacity as a ketone, $(H_3C)_3.C—CO—CH_3$, and in synthetic reactions. It lends itself to the latter in a remarkable manner. The author investigates its action on magnesium methyl bromide and cyanhydric acid, and all his experiments confirm the ketone nature of pinacoline. It s remarkable both from its origin and its properties,

**Phosphorus Chloronitride.**—MM. Besson and Rosset.—Phosphorus chloronitride can be prepared by the action of heat on $PCl_5.8NH_3$, but only in very small quantities. Water reacts upon it, and the action is the best and most rapid in sealed tubes at 150—200° :—$(PCl_2N)_3+12H_2O=6HCl+3PO_4H_3+3NH_3$. Oxygen has no action upon it, but during the formation of ozone the nitrogen products react slightly upon it, forming a brownish yellow solid, the composition of which has not yet been determined. Nitrogen peroxide has the following reaction: $2(PCl_2N)+4NO_2=2N_2O+NOCl+P_2O_5+3Cl+N$.

**Isomorphism of Mercuric Iodide with Zinc and Cadmium Iodides.**—A. Duboin.—Mercuric iodide will crystallise in all proportions with the iodides of zinc and cadmium; this fact constituting an interesting new case of isomorphism.

**Crystallography of Iron.**—F. Osmond and G. Cartaud.—The authors continue their investigations on the subject of the crystallography of iron, and now investigate manganese steel after tempering it in water.

**Determination of the Transformation-points of certain Steels by the Method of Electric Resistance.**—P. Fournel.—The method of electric resistance allows of the determination of the critical points of the five specimens of steel examined, containing varying proportions of carbon, silicon, and manganese.

**Solubility of Carbon in Calcium Carbide.**—H. Morel Kahn.—The author heats in an electric furnace a mixture of lime and sugar-charcoal. The carbide obtained is crystalline and is attacked by water. If the residue is washed with pure hydrochloric, nitric, and hydrofluoric acid, and then well with water, graphite remains, which contains a variable but very small quantity of carbon silicide as an impurity.

**Action of Urethane and Urea on Ethyl Glyoxylate. New Synthesis of Allantoin.**—L. J. Simon and G. Chavanne.—When ethyl glyoxylate acts upon urethane, it gives diurethane-glyoxylic ether, $\begin{matrix}CO_2C_2H_5—NH\\CO_2C_2H_5—NH\end{matrix}>CH—CO_2C_2H_5$. When the same substance is condensed with urea, the product obtained, when analysed, consists of a hitherto unknown ethyl allantoate, $\begin{matrix}NH_2—CO—NH\\NH_2—CO—NH\end{matrix}>CH—CO_2C_2H_5$.

**Formation of Indazylic Derivatives of *o*-Hydrazobenzoic Acid.**—P. Carré.

**Ethyl Dioximidosuccinate.**—A. Wahl.—The author makes a series of experiments on the constitution of ethyl dioximidosuccinate.

**A Method of Reaction of certain Anhydrides of Acids. New Series of Acids having a Pyranic Radicle.**—R. Fosse.—The anhydrides of certain acids produce with the hydroxyl derivatives of dinaphthopyrane and of xanthane a curious result, which the author proceeds to investigate.

**New Method of Estimating the Casein in Cheese.**—A. Trillat and M. Sauton.

## MISCELLANEOUS.

**British Association for the Advancement of Science.**—The following are names of the Officers and Committee of Section B (Chemistry) at the York Meeting of the British Association :—

*President*—Prof. Wyndham R. Dunstan, M.A., LL.D., F.R.S.

*Vice-Presidents*—G. T. Beilby, F.R.S.; Hofrat Dr. H. Caro; Prof. A. Haller; A. Vernon Harcourt, F.R.S.; Prof. Dr. A. Liebermann; Com.-Rat Dr. von Martius; Prof. P. van Romburgh; Sir William H. Perkin, F.R.S.; Prof. A. Smithells, F.R.S.; Prof. W. A. Tilden, F.R.S.

*Secretaries*—Prof. W. J. Pope, F.R.S. (Recorder); Dr. E. F. Armstrong; Prof. A. W. Crossley, D.Sc., Ph.D.; S. H. Davies.

*Committee*—Prof. H. E. Armstrong, F.R.S.; Dr. Barger; W. Barlow; Dr. P. P. Bedson; Prof. E. Divers, F.R.S.; Prof. H. B. Dixon, F.R.S.; Prof. J. J. Dobbie, F.R.S.; T. Fairley; Prof. A. G. Green; Dr. Greshoff; A. D. Hall, M.A.; Prof. G. G. Henderson, D.Sc.; Dr. T. A. Henry; Francis Jones; Dr. A. Lapworth; Dr. Bevan Lean; S. Leetham; Dr. Le Sueur; D. A. Louis; Dr. T. M. Lowry; Dr. H. Marshall, F.R.S.; Prof. H. A. Miers, F.R.S.; Dr. D. H. Nagel; Prof. M. A. Parker; Prof. A. G. Perkin, F.R.S.; Prof. W. H. Perkin, F.R.S.; H. Ramage, M.A.; Sir W. Ramsay, F.R.S.; Rev. A. W. Richards; H. Richardson, M.A.; J. Smyth, M.A.; J. Spiller; Prof. J. J. Sudborough; Dr. J. F. Thorpe; G. Ward.

The Papers brought before the Section were as follows;—

Presidential Address.

*S. Leetham and W. Cramp*—The Electrical Discharge in Air and its Applications.

*Prof. van Romburgh*—The 1 : 3 : 5-Hexatrien.

*Dr. T. M. Lowry*—Report on Dynamic Isomerism.

*Prof. A. W. Crossley*—Report on Hydro-aromatic Substances.

*G. Barger and F. H. Carr*—Note on Ergot Alkaloids.

*A. Vernon Harcourt*—Effect upon the Concentration of a Solution of the presence of an Excess of Undissolved Salt.

*G. Beilby*—Crystallisation of Gold in the Solid State.

*Prof. H. A. Miers and Miss F. Isaac*—Temperature at which Water Freezes in Sealed Tubes.

Discussion on the Production of Prussic Acid by Plants. (Papers contributed by the President, Dr. Henry, Prof. van Romburgh, Dr. Greshoff, and others).

*Dr. Greshoff*—Chemical Research in the Dutch East Indies.

*T. Jamieson*—Utilisation of Nitrogen in Air by Plants.

*A. D. Hall and C. T. Gimingham*—Action of Ammonium Salts upon Clay and kindred Substances.

*Francis V. Darbishire and Dr. E. J. Russell*—Oxidation in Soils and its Relation to Productiveness.

*S. S. Pickles*—Report on the Present Position of the Chemistry of Rubber.

*Prof. Carl Herries (Kiel)*—Constitution of Caoutchouc.

*Prof. W. A. Tilden*—Polymerisation of Isoprene.

*Prof. W. A. Tilden*—Constituents of *Dyera Costulata*.

*H. H. Robinson*—Report on the Present Position of the Chemistry of Gums.

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*R. J. Caldwell*—Report on the Hydrolysis of Sugars.

*W. Popplewell Bloxam*—Method of Determining Indigotin.

The Factors which determine Minimal Diet Values. (Joint Discussion with Section I. Opened by Dr. F. Gowland Hopkins).

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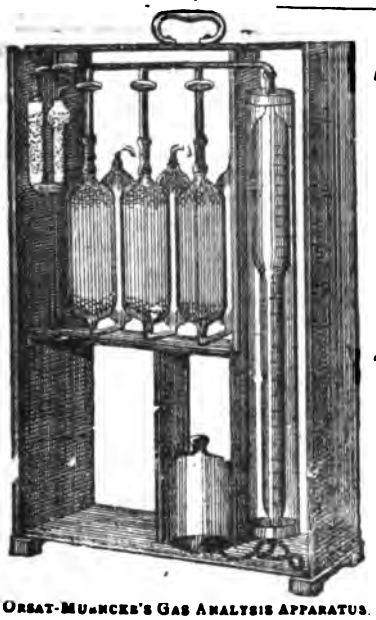

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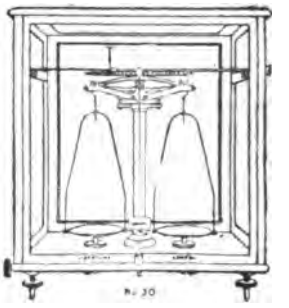

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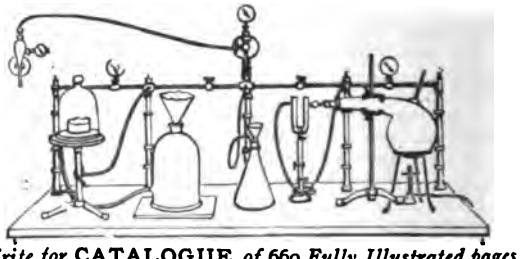

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THE CHEMICAL NEWS.

Vol. XCIV., No. 2438.

# BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

York, 1906.

## INAUGURAL ADDRESS OF THE PRESIDENT,

Prof. E. Ray Lankester, M.A., LL.D., D.Sc., F.R.S., F.L.S., Director of the Natural History Departments of the British Museum.

(Concluded from p. 66).

### II. *The Advancement of Science as Measured by the Support given to it by Public Funds, and the Respect accorded to Scientific Work by the British Government and the Community at large.*

Whilst I have been able, though in a very fragmentary and incomplete way, to indicate the satisfactory and, indeed, the wonderful progress of science since this Association last met in York, so far as the making of new knowledge is concerned, I am sorry to say that there is by no means a corresponding "advancement" of Science in that signification of the word which implies the increase of the influence of science in the life of the community, the increase of the support given to it, and of the desire to aid in its progress, to discover and then to encourage and reward those who are specially fitted to increase scientific knowledge, and to bring it to bear so as to promote the welfare of the community. I am speaking on a privileged occasion to a body of men who are met together for the Advancement of Science, and I claim the right to say to them without offence to the representatives of institutions which I criticise, what is in my mind.

It is, unfortunately, true that the successive political administrators of the affairs of this country, as well as the permanent officials, are altogether unaware to-day, as they were twenty-five years ago, of the vital importance of that knowledge which we call science, and of the urgent need for making use of it in a variety of public affairs. Whole departments of Government in which scientific knowledge is the one thing needful are carried on by ministers, permanent secretaries, assistant secretaries, and clerks who are wholly ignorant of science, and naturally enough dislike it since it cannot be used by them, and is in many instances the condemnation of their official employment. Such officials are, of course, not to be blamed, but rather the general indifference of the public to the unreasonable way in which its interests are neglected.

A difficult feature in treating of this subject is that when one mentions the fact that ministers of State and the officials of the public service are not acquainted with science, and do not even profess to understand its results or their importance, one's statement of this very obvious and notorious fact is apt to be regarded as a personal offence. It is difficult to see wherein the offence lies, for no one seeks to blame these officials for a condition of things which is traditional and frankly admitted.

This is really a very serious matter for the British Association for the Advancement of Science to consider and deal with. We represent a line of activity, a group of professions which are in our opinion of vital importance to the well-being of the nation. We know that those interests which we value so highly are not merely ignored and neglected, but are actually treated as of no account or as non-existent by the old-established class of politicians and administrators. It is not too much to say that there is a natural fear and dislike of scientific knowledge on the part of a large proportion of the persons who are devoid of it, and who would cease to hold, or never have held, the positions of authority or emolument which they now occupy, were scientific knowledge of the matters with which they undertake to deal required of them. This is a thorny subject, and one in which, however much one may endeavour to speak in general terms, it is difficult to avoid causing personal annoyance. Yet it seems to me one which, believing as I do that it is of most urgent importance, it is my duty as your President to press upon the attention of the members of the British Association. Probably an inquiry into, and discussion of, the neglect of science and the questionable treatment of scientific men by the administrative departments of Government, would be more appropriate to a committee appointed by the Council of the Association for this purpose than to the Presidential Address.

At the same time, I think the present occasion is one on which attention should be drawn in general terms to the fact that science is not gaining "advancement" in public and official consideration and support. The reason is, I think, to be found in the defective education, both at school and university, of our governing class, as well as in a racial dislike among all classes to the establishment and support by public funds of posts which the average man may not expect to succeed by popular clamour or class privilege in gaining for himself—posts which must be held by men of special training and mental gifts. Whatever the reason for the neglect, the only remedy which we can possibly apply is that of improved education for the upper classes, and the continued effort to spread a knowledge of the results of science and a love for it amongst all members of the community. If members of the British Association took this matter seriously to heart they might do a great deal by insisting that their sons, and their daughters too, should have reasonable instruction in science both at school and college. They could, by their own initiative and example, do a good deal to put an end to the trifling with classical literature and the absorption in athletics which is considered by too many schoolmasters as that which the British parent desires as the education of his children.

Within the past year a letter has been published by a well-known nobleman, who is one of the Trustees of the British Museum, holding up to public condemnation the method in which the system laid down by the officials of the Treasury and sanctioned by successive Governments, as to the remuneration of scientific men, was applied in an individual case. I desire to place on record here the Earl of Crawford's letter to *The Times* of October 31, 1905, for the careful consideration of the members of the British Association and their friends. When such things are done, science cannot be said to have advanced much in public consideration or Governmental support.

*To the Editor of The Times.*

Sir,—The death, noted by you to-day, of my dear friend and colleague Dr. Copeland, His Majesty's Astronomer for Scotland, creates a vacancy in the scientific staff of Great Britain.

Will you permit me, Sir, to offer a word of warning to any who may be asked to succeed him?

Students or masters of astronomy are not, in the selfish sense, business men, nor are they as a general rule overburdened with this world's goods. It behoves them henceforth to take more care as to their future in case of illness or physical infirmity, and not to trust to the gratitude or generous impulse of the Treasury Department.

In old days it was the custom when a man distinguished in science was brought into a high position in the Civil Service that he was credited with a certain number of years' service ranking for pension. This practice has been done away with, and a bargain system substituted. A short while ago the growing agonies of heart disease caused Dr. Copeland to feel that he was less able to carry on the duties of his post, and he

determined to resign; but he learnt that under the scale, and in the absence of any special bargain, the pension he would receive would not suffice for the necessities of life. The only increase his friends could get from the Treasury was an offer to allow him about half-a-crown a week extra by way of a house.

Indignant and ashamed of my Government, I persuaded Dr. Copeland to withdraw his resignation and to retain the official position which he has honoured till his death.

I trust, Sir, that this memorandum of mine may cause eminent men of science who are asked to enter the service of the State when already of middle age to take heed for their future welfare.—I am, Sir, your obedient servant,

CRAWFORD.

2, Cavendish Square, October 28.

It is more agreeable to me not to dwell further on the comparative failure of science to gain increased influence and support in this country, but to mention to you some instances on the other side of the account. As long ago as 1842 the British Association took over and developed an observatory in the Deer Park at Kew, which was placed at the disposal of the Association by Her Majesty the Queen. Until 1871 the Association spent annually a large part of its income—as much in later years as £600 a year in carrying on the work of the Kew Observatory, consisting of magnetic, meteorological, and physical observations. In 1871 the Association handed over the Observatory to the Royal Society, which had received an endowment of £10,000 from Mr. Gassiot for its maintenance, and had further devoted to that purpose considerable sums from its own Donation Fund and Government grant. Further aid for it was also received from private sources. From this Observatory at last has sprung, in the beginning of the present century, the National Physical Laboratory in Bushey Park, a fine and efficient scientific institution, built and supported by grants from the State, and managed by a committee of really devoted men of science who are largely representatives of the Royal Society. In addition to the value of the site and buildings occupied by the National Physical Laboratory, the Government has contributed altogether £34,000 to the capital expenditure on new buildings, fittings, and apparatus, and has further assigned a grant of £6000 a year to the working of the laboratory. This institution all men of science are truly glad to have gained from the State, and they will remember with gratitude the statesmen—the late Marquis of Salisbury, the Right Hon. Arthur J. Balfour, Mr. Haldane, and others—as well as their own leaders—Lord Rayleigh, Sir William Huggins, and the active body of physicists in the Royal Society who have carried this enterprise to completion. The British Association has every reason to be proud of its share in early days in nursing the germ at Kew which has at length expanded into this splended national institution.

I may mention also another institution which, during the past quarter of a century, has come into existence and received, originally through the influence of the late Lord Playfair (one of the few men of science who has ever occupied the position of a Minister of the Crown), and later by the influence of the Right Hon. Joseph Chamberlain, a subsidy of £1000 a year from the Government, and a contribution of £5000 towards its initial expenses. This is the Marine Biological Association, which has a laboratory at Plymouth, and has lately expended a special annual grant, at the spontaneous invitation of His Majesty's Treasury, in conducting an investigation of the North Sea in accordance with an international scheme devised by a central committee of scientific experts. This scheme has for its purpose the gaining such knowledge of the North Sea and its inhabitants as shall be useful in dealing practically and by legislation with the great fisheries of that area. You will, perhaps, not be surprised to hear that there are persons in high positions who, though admittedly unacquainted with the scientific questions at issue or the proper manner of solving them, are discontented with the action of the Government in entrusting the expenditure of public money to a body of scientific men who give their services, without reward or thanks, to carrying out the purposes of the international inquiry. Strange criticisms are offered by these malcontents in regard to the work done in the international exploration of the North Sea, and a desire is expressed to secure the money for expenditure by a less scientific agency. I do not hesitate to say here that the results obtained by the Marine Biological Association are of great value and interest, and, if properly continued and put to practical application, are likely to benefit very greatly the fishery industry; on the other hand, if the work is cut short or entrusted to incompetent hands, it will no doubt be the case that what has already been done will lose its value—that is to say, will have been wasted. There is imminent danger of this perversion of the funds assigned to this scientific investigation taking place. There is no guarantee for the continuance of any funds or offices assigned to science in one generation by the officials of the next. The Mastership of the Mint held by Isaac Newton, and finally by Thomas Graham, has been abolished, and its salary appropriated by non-scientific officials. Only a few years ago it was with great difficulty that the Government of the day was prevented from assigning the Directorship of Kew Gardens to a young man of influence devoid of all knowledge of botany!

One of the most solid tests of the esteem and value attached to scientific progress by the community is the dedication of large sums of money to scientific purposes by its wealthier members. We know that in the United States such gifts are not infrequent; they are rare in this country. It is therefore with especial pleasure that I call your attention to a great gift to science in this coun try made only a few years ago. Lord Iveagh has endowed the Lister Institute, for researches in connection with the prevention of disease, with no less a sum than a quarter of a million pounds sterling. This is the largest gift ever made to science in this country, and will be productive of great benefit to humanity. The Lister Institute took its origin in the surplus of a fund raised by Sir James Whitehead when Lord Mayor, some sixteen years ago, for the purpose of making a gift to the Pasteur Institute in Paris, where many English patients had been treated, without charge, after being bitten by rabid dogs. Three thousand pounds was sent to M. Pasteur, and the surplus of a few hundred pounds was made the starting-point of a fund which grew, by one generous gift and another, until the Lister Institute on the Thames Embankment at Chelsea was set up on a site presented by that good and high-minded man, the late Duke of Westminster.

Many other noble gifts to scientific research have been made in this country during the period on which we are looking back. Let us be thankful for them, and admire the wise munificence of the donors. But none the less we must refuse to rely entirely on such liberality for the development of the army of science, which has to do battle for mankind against the obvious disabilities and sufferings which afflict us and can be removed by knowledge. The organisation and finance of this army should be the care of the State.

It is a fact which many of us who have observed it regret very keenly, that there is to-day a less widespread interest than formerly in natural history and general science, outside the strictly professional arena of the school and university. The field naturalists among the squires and the country parsons seem nowadays not to be so numerous and active in their delightful pursuits as formerly, and the Mechanics' Institutes and Lecture Societies of the days of Lord Brougham have given place, to a very large extent, to musical performances, bioscopes, and other entertainments, more diverting, but not really more capable of giving pleasure than those in which science was popularised. No doubt the organisation and professional character of scientific work are to a large extent the cause of this

alling-off in its attraction for amateurs. But perhaps that decadence is also due in some measure to the increased general demand for a kind of manufactured gaiety, readily sent out in these days of easy transport from the great centres of fashionable amusement to the provinces and rural districts.

In conclusion, I would say a word in reference to the associations of our place of meeting, the birthplace of our Society. It seems to me not inappropriate that a Society for the Advancement of Science should have taken its origin under the walls of York Minster, and that the clergy of the great cathedral should have stood by its cradle. It is not true that there is an essential antagonism between the scientific spirit and what is called the religious sentiment. "Religion," said Bishop Creighton, "means the knowledge of our destiny and of the means of fulfilling it." We can say no more and no less of Science. Men of Science seek, in all reverence, to discover the Almighty, the Everlasting. They claim sympathy and friendship with those who, like themselves, have turned away from the more material struggles of human life, and have set their hearts and minds on the knowledge of the Eternal.

## ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.

YORK, 1906.

By Prof. WYNDHAM DUNSTAN, M.A., LL.D., F.R.S., F.C.S., President of the Section.

(Concluded from p. 69).

I HAVE thought that it would be of interest on the present occasion if some account were given in the Section of the chemistry of certain of the raw materials employed in the principal manufacturing industries of the city of York. These industries are vitally concerned with an adequate supply of certain raw products of tropical origin, especially cocoa and gums. In connection with the first of these, which has hitherto been obtained chiefly from the West Indies, a new industry of cocoa production has sprung up in West Africa, notably in the Gold Coast and in Lagos. This West African cocoa presents some peculiarities which have rendered it desirable to examine the nature of its constituents. Gums of the nature of gum arabic are at present chiefly derived from the French Colony of Senegal. It is, however, clear from the examination of gum collected in West Africa that that country, and especially Northern Nigeria, will be able in the future to contribute to the needs of the British manufacturer, in addition to the Sudan, India, and Australia, which will also be able to make important contributions. In connection with the investigation of these gums derived from new sources at the Imperial Institute, the very remarkable observation has been made that certain gums from India and the Colonies possess the property of evolving acetic acid when exposed to the air. The chemical constitution of one of these gums has been fully investigated at the Imperial Institute by Mr. H. H. Robinson, who will contribute a paper on the subject to the Section, in which he will show that the production of acetic acid is due to the elimination of an acetyl group by hydrolysis through the moisture of the air. He has also succeeded in elucidating to a large extent the chemical nature of the gum. Mr. Robinson will also make a report on the present position of the chemistry of gums, a class of substances whose constitution is exceptionally difficult to unravel. Little, if any, advance has been made in recent years on the well-known researches of O'Sullivan.

There is no more important group of questions demanding attention from the chemist at the present time than those connected with the production of indiarubber or caoutchouc. An enormous increase in the demand for indiarubber has taken place in the last few years, and last year the production was not less than 60,000 tons. Until recently the supply of rubber came chiefly from two sources—the forests of Brazil, which contain the tree known as *Hevea brasiliensis*, furnishing the Para rubber of commerce which commands the highest price, and the forests of Africa, where climbing plants, generally of the Landolphia class, also furnish rubber. The increased demand for caoutchouc has led to the extensive planting of the Para rubber tree, especially in Ceylon and in the Federated Malay States. Systematic cultivation and improved methods of preparation are responsible for the fact that the product of the cultivated tree, which begins to furnish satisfactory rubber when six or seven years old, is now commanding a higher price than the product of the wild tree in Brazil. It is estimated that within the next seven years the exports of cultivated indiarubber from Ceylon and the Federated Malay States will reach between ten and fifteen million pounds annually, and that after fifteen years they may exceed the exports of the so-called wild rubber from Brazil.

The services which chemistry can render to the elucidation of the problems of rubber production and utilisation are very numerous. Methods of treatment depending on a knowledge of the other constituents of the latex have led to the production of rubber in a purer condition. Much still remains to be elucidated by chemical means as to the nature of the remarkable coagulation of the latex. As is well known, the latex is a watery fluid resembling milk in appearance which contains the rubber, or, as I think more probable, the immediate precursor of rubber, together with proteids and other minor constituents. The constituent furnishing rubber is in suspension, and rises like cream when the latex is at rest. On the addition of an acid, or sometimes of alkali, or even on mere exposure, coagulation takes place and the rubber separates as a solid, the other constituents for the most part remaining dissolved in the aqueous liquid or "serum." The first view taken of the nature of the coagulation process was that, like the coagulation of milk by acids, it is dependent upon a process of proteid coagulation, the separated proteids carrying down the rubber during precipitation.

This explanation cannot, however, be considered complete by the chemist, and there are peculiarities connected with the coagulation of the latex which are opposed to the view that it is wholly explained by the coagulation of the associated proteids. The experimental investigation of the question on the chemical side is beset with many difficulties which are increased if access cannot be had to fresh latex. A number of experiments were made at the Imperial Institute with latex forwarded from India. The difficulties contended with in preventing coagulation during transit were great, but in the case of the latex derived from certain plants these were to some extent surmounted, and the results obtained, especially with reference to the behaviour of certain solvents towards the latex, led to the conclusion that "coagulation" can take place after removal of the proteids, and that in all probability it is the result of the polymerisation of a liquid which is held in suspension in the latex and on polymerisation changes into the solid colloid which we know as caoutchouc. Weber, by experiments conducted in South America with fresh latex, arrived at a similar conclusion, which later workers have confirmed. Although the nature of the process is not yet completely elucidated, there is little room for doubt that the coagulation is due to the polymerisation of a liquid and possibly of a liquid hydrocarbon contained in the latex. For the chemist the important question remains as to the nature of this liquid from which caoutchouc is formed.

The chemical nature of caoutchouc is a subject which has attracted the attention of distinguished chemists from the middle of the eighteenth century, among them being Faraday, Liebig, and Dalton. Faraday was the first to examine the constituents of the latex of *Hevea brasiliensis*. It is only in recent years that our knowledge of the constitution of organic compounds, and especially of the terpene group, has rendered it possible to make any great advance.

It is interesting to record that Greville Williams, in 1860, made most important contributions to this subject. He identified a new hydrocarbon, isoprene, as a decomposition product of caoutchouc, and recognised its polymeric relation to caoutchouc.

The results obtained from the analytical side, and especially the formation of di-pentene and isoprene by pyrogenic decomposition of caoutchouc, had pointed to the fact that caoutchouc was essentially a terpenoid polymer of the formula $C_{10}H_{16}$. Harries finds, however, that the ozonide of caoutchouc, when distilled with steam, breaks up into lævulinic aldehyde, lævulinic acid, and hydrogen peroxide, and he concludes from this that caoutchouc is a polymer of an 1 : 5 dimethyl cyclo octadien. Whilst Harries' work has brought us much nearer the goal, and has led to the discovery of a new method of investigation through the ozonides, which is obviously of wide application, it cannot yet be said that the constitution of caoutchouc has been settled or its relation to the parent substance of the latex definitely established. It has still to be shown how a closed-chain hydrocarbon such as Harries' octadien can undergo polymerisation forming the colloid caoutchouc.

There are strong arguments for the view that the constitution of the parent substance present in the latex is nearly related to that of isoprene. This remarkable hydrocarbon of the formula $C_5H_8$, first obtained by Greville Williams from the dry distillation of rubber, is an unsaturated olefenic hydrocarbon which is found among the products, resulting from heating caoutchouc. It readily polymerises, forming di-pentene. Bouchardat noticed that this hydrocarbon obtained from the pyrogenic decomposition of caoutchouc furnished a substance identical with rubber when acted on by hydrochloric acid and under other conditions. To Wallach and also to Tilden is due the further important observation that when isoprene prepared from oil of turpentine is kept for some time, it gradually passes into a substance having all the characteristic properties of caoutchouc.

I have very briefly drawn attention to the present position of our knowledge of the chemistry of caoutchouc in illustration of the interest which attaches to the examination of vegetable products, and also because of the immense importance of the problem from the practical and commercial standpoint. Chemistry in this case holds the premier position in reference to this subject, and to a large extent may be said to hold the key to the future of the rubber industry in all its phases. The discovery of better methods of coagulation, preparation, and purification will be effected through chemical investigation, as will also the determination of the manner of utilising the various other plants which furnish rubber-like latices. That the physical properties of raw rubber, on which its technical value depends, are to be correlated with the chemical composition of the material there can be no doubt. The chemical analysis of raw rubber, as at present conducted, is, however, not always to be taken by itself as a trustworthy criterion of quality, and more refined processes of analysis are now needed. Although the finest caoutchouc for technical purposes is only yielded by some half-dozen plants, under whose names these varieties of caoutchouc pass, there can scarcely be a doubt that the elastic substance in each case possesses a very similar, if not identical, chemical structure. Nearly all the latices and similar fluids furnished by plants contain more or less caoutchouc. Even opium, which is the dried juice of the capsule of the poppy, contains caoutchouc, whilst the opium yielded by certain Indian species contains a notable proportion. Chemistry must determine the means by which caoutchouc can best be separated from these relatively poor latices. In view of the increasing production of the nearly pure caoutchouc which is furnished by *Hevea brasiliensis*, *Funtumia elastica*, *Castilloa elastica*, *Ficus elastica*, and a few other plants which occur or can be cultivated in several of our tropical Possessions, the question is not a pressing one at the moment.

Moreover, it cannot be doubted that chemical science will sooner or later be able to take a definite step towards the production of rubber by artificial means.

The production of caoutchouc by chemical means has, indeed, virtually been accomplished in its formation from isoprene. The exact nature of this change has still to be determined. When this has been done it will only remain to cheapen the cost of production to make the manufacture of synthetic rubber a purely practical problem. I should be the last to discourage the great extension of rubber planting which is now taking place. It is warranted by the present demand for the material. It has also to be remembered that the actual cost of producing raw rubber, which is at present about one shilling per pound, will probably be reduced, and the market price of rubber may eventually be so considerably lowered that, as with quinine, the synthetic production could not be profitably carried on. That is a question which involves many factors at present unknown, and only time can decide. Chemists may, however, confidently predict that before the British Association again meets at York the synthetic production of rubber will be a fully accomplished fact.

As I have said, our science is concerned with nearly every problem connected with the great rubber industry, and in concluding these few remarks I may allude to the production of vulcanised rubber depending on the formation of additive compounds of the hydrocarbon with sulphur. In this connection I should mention the recent experiments of Mr. Bamber in Ceylon, which appear to show that vulcanisation may be accomplished by acting on the uncoagulated latex with chloride of sulphur. If this proves to be practicable, it may mean the transference to the tropics of the subsidiary industry of vulcanisation, which is at present carried on in Europe.

Owing to the importance and interest which attach to the chemistry of rubber, it is to form an important feature in the work of this Section at the York Meeting. Papers will be contributed by some of the best known workers in this field, by Professor Tilden, and by Professor Harries, of Kiel, who will give an account of his recent work; whilst Mr. Pickles, of the Imperial Institute, will present a report summarising the whole of our chemical knowledge of the subject.

The chemical investigation of raw materials often raises, unexpectedly, problems of great scientific interest. The examination at the Imperial Institute of the seeds of the Para rubber tree (*Hevea brasiliensis*) has shown that they contain what proves to be a valuable drying oil, and in the course of the investigation it was ascertained that there is also present in the seeds an enzyme closely allied to, if not identical with, lipase, which is capable of splitting the oil by hydrolysis into glycerin and the free fatty acid. Subsequently, during the examination of other oil seeds similar enzymes have been detected, and it would appear probable that most oil seeds may prove to contain an enzyme capable of decomposing the fatty constituent.

Another subject of great chemical interest and botanical importance which has come into prominence in connection with the Indian and Colonial work of the Imperial Institute is to be included in a joint discussion which has been arranged with the Section of Botany. I refer to the production of prussic acid by plants, which, as I have elsewhere suggested, it is convenient to refer to as cyanogenesis. In this discussion we shall have the advantage of the co-operation of Professor van Romburgh and Dr. Greshoff, whose work with Dr. Treub of Java on this subject is known to chemists and botanists alike. The history of the origin of the several investigations in which Dr. Henry has been associated with me is not without interest in connection with the principal subject of this Address. During the first British expedition to the Sudan against the Mahdi a number of transport animals were poisoned through eating a small vetch which springs up in the Nile Valley during the fall of the river. The plant (*Lotus arabicus*) is well known to the Arabs, by whom it is cut when fully grown, and used as fodder for animals.

The results of the investigation of this matter which were communicated to the Royal Society proved that the young plant generated prussic acid when crushed with water. It was found to contain a new glucoside lotusin, together with an enzyme capable of decomposing it into prussic acid, dextrose, and a yellow colouring matter, lotoflavin.

The glucoside is of special chemical interest, as being the only one known which contains the cyanogen group attached in the molecule to the sugar residue. Further investigation has shown that other fodder plants which are occasionally poisonous owe this character to the existence of other cyanogenetic glucosides. In a series of papers communicated to the Royal Society, Dr. Henry and I have described the properties and constitution of dhurrin from *Sorghum vulgare*, and of phaseolunatin, which we have shown to be responsible for the production of prussic acid by *Phaseolus lunatus* (Lima beans), *Manihot utilissima* (cassava or tapioca), and by linseed (the flax plant). Phaseolunatin is remarkable in furnishing acetone as one of its products of hydrolysis. The investigation, besides fulfilling the primary purpose for which it was carried out, has raised a host of problems;—as to the constitution of glucosides, the nature of the enzymes which accompany them in the plants, and also in relation to the fundamental question of plant metabolism.

Another subject of Imperial as well as National importance is to be the subject of a joint discussion with the Section of Physiology. I refer to the problem of diet. As chemists we are interested in this subject chiefly from the point of view of the composition of foods, and of the molecular structure which is associated with dietetic value. The first attempt to deal with the matter from the scientific side was made by a great chemist, Liebig. We are now in a position to investigate the problem more minutely, and the work of American physiologists has already led to important results. We have still to learn how materials such as rice and potatoes, which are nearly free from proteids, continue nevertheless to serve as the main diet of large numbers of people. It would seem that the best plan of operations will be for physiologists to settle by the accurate methods now available the precise value of typical foodstuffs, and for the chemist to deal with these in relation to their composition, and finally with reference to the constitution of their constituents. The time has come when an advance must be made from the chemical side in the analytical methods employed for gauging the value of food materials.

I feel that I have said much, but that I have left still more unsaid on many topics. I must leave almost untouched the entire subject of mineral chemistry, which is not only important in connection with the determination of the resources of India and the Colonies, but is also a subject somewhat neglected on its chemical side, which has been recently brought into prominence through the discovery of radio-activity.

The new radio-active mineral thorianite, from Ceylon, of which Mr. Blake and I have given an account to the Royal Society, brings me at once to a subject which raises the most fundamental of chemical questions, the nature of the elements and of the atom. The recent discussions of this subject have become so purely speculative that, whilst chemistry is bound to follow the lead of physics in this matter, chemists are inclined to consider that more well-ascertained facts are needed for any further discussion to be profitable from the chemical side.

In this address I have ventured to urge the fuller recognition by Government of the scientific method as a powerful instrument in promoting the commercial development of the Colonies, and I have drawn attention to the important part the science of chemistry can play in the Imperial work of developing the resources of our Possessions.

No apology is needed in this place for directing attention to a subject which involves a most important practical application of our science, since one of the principal functions of the British Association is to bring science into close touch with the problems of our national life, and to interest the general public in the application of science to their solution.

I have, however, also shown that many problems of the highest scientific interest arise in connection with the investigation of these economic problems.

The meeting of the British Association coincides this year with the celebration of the Jubilee of the Coal-Tar Colour Industry, and we welcome among us a number of distinguished foreign chemists who have come to join in honouring the great chemist Sir William Perkin, to whom the inception of this industry is due. It is fitting that, as President of the Chemical Section, I should refer to this great occasion in my Address, and express for myself, as well as for the chemists here present, the admiration we feel for Sir William Perkin's genius and for the splendid example he has set in his life-long devotion to experimental research, an example from which all of us have profited who have had the good fortune to come into relation with him.

## CHEMICAL AND ELECTRICAL CHANGES INDUCED BY ULTRA-VIOLET LIGHT.*

By Sir WILLIAM RAMSAY and J. F. SPENCER, M.Sc., Ph.D.

1. LIGHT from an iron arc, falling on earth-connected plates of elements, placed at an angle of 45°, to the cap of an electroscope, discharges the electroscope. Even when an aluminium box, earthed, the top closed with a gold or silver leaf, so as to surround the plate of the electroscope completely, was interposed, discharge still occurred; but its rate was decreased when a thin aluminium leaf was substituted for the gold or silver. Discharge occurred when the electroscope was charged positively, but not negatively; the charge was approximately at 800 volts.

2. As the iron arc proved unsteady, a Cooper-Hewett uviol-glass mercury lamp was substituted. The illumination was insufficient to cause discharge through gold or silver leaf, but took place when the plate of the electroscope was exposed to the reflections. The rate of discharge caused by plates of thirty-three elements, metals and non-metals, were in the order of their position in the electric series, gold, iron, and manganese being notable exceptions. No discharge took place if the electroscope was negatively charged.

3. The rate of discharge was greatly increased, and the order was practically the same, when the plates formed part of the electroscope; in this case, however, it was necessary to charge the electroscope negatively, and again to 800 volts.

4. The sulphides of a number of the metals in the form of plates also caused discharge, but at a much slower rate; some iodides were also measured, and found to cause discharge. The order, however, is quite distinct from that of the elements.

5. The plates gave a more rapid discharge with a fresh surface; they "tired," however, and the rate of falling off presented some peculiarities. For dyad metals, the curve presents two obvious "breaks," and two phases of constant rate of "tiring;" for tetrad metals, four such stages were observed.

6. A unifluid cell, containing two identical plates of copper, cadmium, or gold, gives a small change of potential when one plate is illuminated by ultra-violet or sun-light, in a tube of uviol glass, the other plate being kept in the dark. That chemical action has occurred was obvious on examining the exposed plate after insolation.

All these phenomena are brought into line on the hypothesis that elements and compounds, when illuminated by ultra-violet light, discharge corpuscles.

* Abstract of Paper read before the British Association (Section A), York Meeting, 1906.

## DYNAMIC ISOMERISM.*

Attention has been directed during the past two years mainly to the determination of the proportions in which isodynamic compounds are in equilibrium in solution. The method of investigation, which was briefly referred to in the last Report (Cambridge, 1904, p. 218; compare Lowry, *Proc.*, 1903, xix., 156), involves the measurement of the solubility of one of the isomerides, both before and after isomeric change has taken place. Only one of the solid isomerides can persist in stable equilibrium with the solution. This is not necessarily the form which predominates in the liquid; indeed, the modification which thus persists may vary with the solvent (Dr. Whiteley, *Trans.*, 1899, lxxv., 231) and differ in closely related compounds (compare nitro-camphor and its $\pi$-bromo-derivative). The concentration of the original compound is kept substantially constant by stirring the solution with an excess of the solid; any increase which is observed in the concentration of the saturated solution is attributed to the formation in the liquid of one or more dynamic isomerides. If the initial concentration of the saturated solution be A and the final concentration B, the ratio A/B affords a measure of the proportion of the original material present in the solution when equilibrium between the dynamic isomerides is attained.

In applying the method experimentally certain difficulties are encountered.

1. When isomeric change occurs rapidly, the products appear in the solution before the latter is saturated with the original material. In such cases it is necessary to make solubility-measurements at frequent intervals during the early stages of the experiment and to deduce the initial value by extrapolation. When, however, isomeric change proceeds slowly or only after the addition of a catalyst, the measurements can be made at leisure, and the experimental errors are very greatly reduced.

2. Whether isomeric change be rapid or slow, it is essential that the solid used in effecting saturation consist wholly of one isomeride. To ascertain if this be the case, the sample should be extracted at constant temperature with successive quantities of the solvent; if the material be pure, the different extracts should have equal concentrations. In comparing different series of observations, those which give the smallest ratio of initial to final concentration are the more likely to be correct.

3. In deducing the proportion of the original material present in the solution, it has been assumed that the solubility of this form remains constant throughout the experiment and is not affected by the products of isomeric change. This cannot, as a rule, be tested directly, since the method is of greatest value in cases in which the less stable isomerides are unknown or cannot be prepared in a pure state. Important evidence can be obtained, however, by studying the effect of adding to the solvent known quantities of a pure substance of allied structure. Experiments have been made on the influence of glucose on the solubility of galactose, by Mr. Robertson on the influence of $\beta$-methylglucoside on the solubility of the $\alpha$-glucoside, on the influence of $\alpha\pi$-dibromocamphor on the solubility of the $\alpha\pi$-isomeride, and of bromocamphor $\pi$-sulphonamide on that of the $\beta$-sulphonamide: these have shown that in the case of sparingly soluble compounds of high melting-point the change of solubility is insignificant. In the case of soluble compounds of low melting-point the effects produced are no longer negligible, but the correction to be applied may be estimated by similar methods. In the most extreme case that has yet been examined the correction amounts to 2 per cent on the volume concentration or 4 per cent on the weight concentration.

Since the appearance of the last report four investigations dealing with the subject have been completed and described; briefly summarised, the results obtained are as follows:—

1. *Nitro-derivatives of Camphor* (Lowry and Robertson, *Trans.*, 1904, lxxxv., 1541).—The solubility of normal nitro-camphor in light petroleum increases in the course of a few hours in the ratio 0·82 : 1, indicating that when equilibrium is attained the normal and pseudo forms are present in the ratio 82 : 18 or 5 : 1 approximately. In the case of the $\pi$-bromo derivative, the pseudo-form is that which persists in contact with the solution: its solubility increases in the ratio 0·17 : 1; the isomerides are therefore present in the ratio 83 : 17, or (as in the case of nitro-camphor itself) 5 : 1 approximately.

2. *Glucose and Galactose* (Lowry, *Trans.*, 1904, lxxxv., 1551).—In methyl-alcoholic solutions one-half of the sugar is in the $\alpha$-form, the other half probably consisting almost entirely of the stereoisomeric $\beta$-sugar. In presence of water the proportion of the $\alpha$-sugar decreases: this might be due to a displacement of the equilibrium between the $\alpha$ and $\beta$ sugars, but is more probably due to the formation of a largely increased proportion of a third form of the sugar, such as the aldehyde or its hydrate. The formation of some such intermediate compound in which the terminal carbon atom is no longer asymmetric appears to be essential to account for the optical inversion which accompanies the interconversion of the $\alpha$ and $\beta$ sugars.

3. *Bromocamphor and Chlorocamphor* (Lowry, *Trans.*, 1906, lxxxix.).—Kipping has shown that these compounds, although stable in neutral solutions, undergo reversible isomeric change in presence of alkalis (*Proc.*, 1905, xxi., 125). This change is accompanied by an increase of solubility in the ratio 0·89 : 1; a similar increase is observed in the case of the $\beta$ and $\pi$ bromo-derivatives of these compounds. In the case of chlorocamphor and bromocamphor the proportions of the $\alpha$-compounds in the solutions are probably somewhat greater than 89 per cent owing to the influence of the $\alpha'$-compound in increasing the solubility of the $\alpha$-compounds. The proportions are estimated at 91 per cent and 93 per cent respectively.

4. *Sulphonic Derivatives of Camphor* (Lowry and Magson, *Trans.*, 1906, lxxxix.).—Kipping has shown that the $\pi$-sulphonic salts derived from $\alpha$-bromocamphor and $\alpha$-chlorocamphor undergo reversible isomeric change in presence of a trace of free alkali (*Proc.*, 1905, xxi., 124). Solubility measurements indicate that similar changes take place in the case of the $\beta$-sulphonic salts, amides, and other derivatives, but the observations are complicated by the fact that the compounds of the $\alpha\beta$-series are able to pass not only into stereoisomeric $\alpha'\beta$ compounds, but also into isomeric sulpholactones. A number of the latter have been examined and described.

The expenses incurred in connection with investigations described above were in part defrayed by a grant made to the Committee in 1904. It is proposed during the coming year to undertake a detailed examination of the optical properties of nitrocamphor and other compounds which exhibit dynamic isomerism in solution. In particular it is proposed to test Biot's hypothesis that anomalous rotatory dispersion is due to the presence in solution of two modifications of a substance—a suggestion which was made some years before the phenomena of dynamic isomerism were clearly understood.

* Report of the Committee, consisting of Professor H. E. Armstrong (Chairman), Dr. T. M. Lowry (Secretary), Professor Sydney Young, Dr. J. J. Dobbie, Dr. A. Lapworth, and Dr. M. O. Forster. (Drawn up by the Secretary). Read before the British Association (Section B), York Meeting, 1906.

**Notice of Removal.**—W. A. Foyle, of Cecil Court, Charing Cross Road, W.C., begs to inform his customers that he has removed to larger and more central premises at 135, Charing Cross Road, W.C., where all further communications should be addressed. The business will in future be carried on under the name of W. and G. Foyle (THE Booksellers).

## SPECTRA OF THE CATHODIC PHOSPHORESCENCE OF TERBIUM AND DYSPROSIUM DILUTED IN LIME.*

By G. URBAIN.

By diluting various pure rare earths in lime and gradually varying the relative proportions of the components of the binary phosphorescent systems so obtained, it is found that the optimum of phosphorescence corresponds to mixtures in which the proportion of rare earth is of the order of the hundredth.

This observation determines the conditions in which it is convenient to work if we wish, in the course of the separations, to take phosphorescence spectra as a guide. In practice it is convenient to mix intimately by chemical means, from 1 to 3 m.grms. of the rare earth with about 1 grm. of pure lime.

When we examine in this manner in a vacuum tube the successive terms of a fractionation, the spectra observed have nearly the sensibility of other spectra, and the agreement of the different spectra (spark, absorption, phosphorescence) which belong to the same element appears clearly if the treatment has been pushed sufficiently far.

It is not the same thing if we observe the phosphorescence which the earths give directly without addition of lime or other diluent earth, or if only insufficient quantities of diluents are added. Certain earths, such as *gadolinia* or *yttria*, then necessarily play the parts of diluents, and we no longer can observe the concordance of the absorption or spark spectra with the spectra of phosphorescence.

The earths which in my treatments are comprised between gadolinium and yttrium are not directly phosphorescent. They contain terbium, dysprosium, and neo-holmium. Hitherto I have not observed any phosphorescence attributable to the latter element.

By diluting the various terms of my fractionations in lime, I have observed only two phosphorescence spectra, the first belonging to terbium, the second to dysprosium.

*Spectrum of Terbium.*

| | |
|---|---|
| 633 | Nebulous, strong. |
| 630 | Weak, connected with the following. |
| 627·5 | Rather strong. |
| 625 to 622 | Nebulous, connected with the following; strong maximum at 624. |
| 619 | Moderate, wide. |
| 601·7 | Strong, sharp. |
| 598·7 | Moderate. |
| 595·5 | Strong. |
| 589·7 | Tolerably strong, sharp. |
| 587·8 | Strong. (Must not be confounded with the moderate and very hazy line of dysprosium which coincides with it in the mixtures). |
| 584·3 | Strong, sharp, and a little more refrangible than the citron band 584·8, with which it is identical in dysprosiferous products. |
| 581·7 | Weak, a little more refrangible than the band 583·2, with which it is united in dysprosiferous products. |
| 578·9 | Very weak. |
| 568·7 to 560·2 | Very diffuse, unsymmetrical band, approximate maximum at 566. |
| 558·8 | Moderate, rather sharp. |
| 557·0 | Middle of a moderate wide band, connected with the following. |
| 555·0 | Very strong, nebulous. |
| 552·1 | Very strong, nebulous. |
| 550·8 | Feeble. |
| 549·5 | Very strong, nebulous. |
| 545·8 | Weak, very hazy. |
| 543·8 | Strong, hazy, connected with the following. |
| 542·5 | Very strong, nebulous. |
| 540 and 539 | Maxima of a moderate, nebulous band. |
| 534 to 522·5 | Nebulous, weak, and unsymmetrical band, with a maximum at 532·3. |
| 503 | Weak, nebulous. |
| 494·5 | Weak, very nebulous. |
| 489·5 | Moderate, diffuse, connected with the following. |
| 485·5 | Very strong and sharp. |
| 482·5 | Moderate, diffuse, connected with the preceding one. |
| 478·5 to 473 | Weak, very diffused band. |
| 467 | Weak, nebulous. |
| 464 | Very weak and diffused. |
| 462 to 457 | Moderate, very diffused band. |
| 447·2 | Rather strong and sharp. |
| 445·5 | Rather strong and sharp. |
| 444 | Moderate, nebulous. |
| 441 | Moderate, nebulous. |
| 439·5 | Strong and sharp. |
| 437 | Very strong and nebulous. |
| 435 | Strong and sharp. |
| 434 | Weak, diffused, connected with the preceding. |
| 430 | Very weak, diffused. |
| 428 | Weak, very diffused. |
| 424·5 | Very weak and diffused. |
| 422 | Moderate, sharp. |
| 420 | Very strong, rather sharp. |
| 419 | Strong, rather sharp. |
| 418 | Strong, rather sharp. |
| 416 | Rather strong, nebulous. |
| 414·5 | Moderate, sharp. |
| 414 | Rather strong, sharp. |
| 413 | Rather strong, sharp. |
| 412 | Rather strong, sharp. |
| 391·5 | Weak, diffused. |
| 390 | Very strong, nebulous. |
| 388 | Strong, diffused. |
| 386·5 to 384 | Moderate, very diffused. |
| 382 | Rather strong, nebulous. |
| 380·5 | Strong, nebulous. |
| 379·5 to 378 | Very strong, probably double. |
| 377 | Strong, nebulous. |
| 375 | Weak, nebulous. |
| 373·5 | Weak, nebulous. |
| 372 | Very weak, nebulous. |

*Spectrum of Dysprosium.*

| | |
|---|---|
| 675 | Approximate centre of a strong, rather sharp band. |
| 667 | Very weak, diffused. |
| 654·5 | Hardly visible. |
| 598·5 to 595 | Rather strong, very diffused band, maximum at 595·8. |
| 587·7 | Moderate, very nebulous band, which must not be confounded with the strong and sharper band of the same wave-length of terbium. |
| 584·8 | Extremely strong and sharp. This is the *citron band* (Gδ) of Sir William Crookes.* |
| 583·2 | Rather strong. |
| 580·5 | Moderate. |
| 578·5 and 577·5 | Doublet of moderate intensity. |
| 576·3 and 575·2 | Doublet of moderate intensity. |
| 573·5 | Weak, very diffused. |
| 570·8 | Rather strong. |
| 569 | Weak, very diffused. |
| 566 to 563·5 | Weak band, approximate maximum at 563·4 |
| 506·3 to 500 | Weak, extremely diffuse band. |
| 495·5 to 491 | Moderate, very diffused. Approximate maximum at 493·5. |
| 490 to 488·2 | Strong, diffused. |

* *Comptes Rendus*, vol. cxliii., p. 229, July 23, 1906.

* M. Urbain is in error. The wave-length of my citron band is 574 (*Phil. Trans.*, May 31, 1883, Part 3, p. 891).—W. C.

| | |
|---|---|
| 486 to 482·5 | Weak band. Maximum at 484·5. |
| 481·5 | Moderate, nebulous. |
| 479·7 | Strong, nebulous. |
| 477 | Weak. |
| 474·8 | Moderate, nebulous. |
| 472·8 | Moderate, nebulous. |
| 469 to 466·5 | Moderate, diffused. |
| 454 | Moderate, diffused. |

I may remark that Sir William Crookes attributes the citron band sometimes to an element, Gδ, sometimes to yttrium.* Long ago, M. Lecoq de Boisbaudran identified the element producing the citron band with his element $Z_1$. I have shown that the element $Z\alpha$ is identical with dysprosium. To the fact that pure yttria does not give the citron band (Lecoq de Boisbaudran, *Comptes Rendus*, 1886, vol. ciii., p. 113), I will add that the earths I have used to determine the preceding spectra contain no trace of yttrium detectable by the spark or the arc, and we know how great is the sensitiveness of the spectrum of the yttrium lines.

* This statement is scarcely accurate. I have always ascribed the citron band (λ 574) to yttrium. But having been led, by the results of long-continued fractionation, to the hypothesis that what we now call yttrium may be a mixture of closely allied bodies one only of which is responsible for the citron band, I have called this hypothetical component of yttrium Gδ (*Proc. Roy Soc.*, 1886, vol. xl., p. 506).—W. C.

THE

# DIRECT ESTIMATION OF NITRO-GLYCERIN IN CORDITE, &c.

By OSWALD SILBERRAD, Ph.D.,
HENRY ABLETT PHILLIPS, and HENRY JOHN MERRIMAN.

No method has hitherto been devised for the direct estimation of nitro-glycerin in cordites and allied explosives. It is customary to extract the nitro-glycerin and mineral jelly with ether, and to weigh the residual nitro-cellulose. Methyl alcohol is used to separate the nitro-glycerin and mineral jelly; the latter being weighed and the former determined by difference. The disadvantages of having no direct method for the estimation of such an important constituent of cordite as nitro-glycerin are manifest.

Firstly, the methods for the determination of mineral jelly are somewhat unsatisfactory. Thus, on keeping a powder, a certain portion of the mineral jelly becomes soluble in methyl alcohol, and is therefore estimated as nitro-glycerin; and, secondly, it not infrequently occurs that the powder contains some additional ingredient, the presence of which precludes the estimation of nitro-glycerin by difference.

The chief difficulties met with in attempting to estimate nitro-glycerin in cordite directly are due to the unavoidable presence of a volatile solvent used for its separation. Such solvents interfere with the reactions of nitro-glycerin to such an extent that all previous attempts to devise quantitative methods have been fruitless.

The present method is based on the reduction of the saponification products of nitro-glycerin to ammonia, and will be found to be satisfactory and accurate.

Saponification alone does not give quantitative results. In this connection, Hay's work should be referred to (*Monit. Scient.*, [3], xv., 424). According to this author, the saponification may be represented by the following equation:—

$$C_3H_5(ONO_2)_3 + 5KOH = KNO_3 + 2KNO_2 + CH_3COOK + HCOOK.$$

The present work has shown, however, that the reaction is not quantitative, ammonia and other products always being simultaneously formed.

## *Experimental.*

*Direct Evaporation of Ethereal Solution of Nitro-glycerin.*—A series of experiments in this direction showed—

(*a*) That ether cannot be removed from nitro-glycerin without loss of the latter;

(*b*) That the loss is reduced to a minimum when the removal of the ether is carried out at a low temperature in a current of air;

(*c*) That even under the most carefully controlled conditions constant results cannot be obtained.

As an example, the following experiment may be cited:—Weighed quantities of nitro-glycerin were dissolved in ether, the ether evaporated in a current of air, and the nitrogen estimated by Lunge's method in the residue.

0·4508 grm. of nitro-glycerin originally taken gave 140·8 c.c. of nitric oxide at 758·9 m.m. and 19° C. (= 18·24 per cent N).

0·4501 grm. of nitro-glycerin originally taken gave 140·5 c.c. of nitric oxide at 762·2 m.m. and 22·8° C. (= 18·07 per cent N).

This corresponds to 98·58 and 97·69 per cent of nitro-glycerin respectively. Experiments were therefore carried out with a view to devising a direct method for estimating nitro-glycerin in an ethereal solution. The results which ultimately led to the development of a satisfactory method are briefly summarised in Table I. From these results it will be seen that it is possible to overcome the difficulties attending the direct estimation of nitro-glycerin in ethereal solution (as obtained in the analysis of cordite) by reducing the saponification products with zinc, iron, and caustic soda. Under these conditions the nitrogen is quantitatively converted into ammonia.

The apparatus* consists of a flask fitted with a Soxhlet extractor, which is also fitted with a very efficient condenser, the whole apparatus being joined together with ground-glass joints. These precautions are necessary in order to avoid loss of nitro-glycerin, which is readily carried away in the ether vapour.

The direct estimation of nitro-glycerin in a cordite is carried out as follows:—

A weighed quantity of the ground cordite, sufficient to yield about 2 grms. of nitro-glycerin, is placed in a thimble in the Soxhlet extractor, 80 c.c. of absolute ether is poured into the flask, and extraction carried out in the usual manner. After the extraction of the cordite is complete, the thimble containing the residual nitro-cellulose is washed with a little fresh ether and removed from the extractor. Two absorption flasks, containing 10 c.c. of N/10 acid, are now affixed to the top of the condenser and excess of sodium ethylate (about 50 c.c. of a solution prepared by dissolving 5 grms. of sodium in 100 c.c. of absolute alcohol) run into the flask little by little by means of a side tube. The reaction takes place rapidly, and is completed by warming on the water-bath for about six hours; its course may be followed by periodically drawing off small samples by means of a tap in the Soxhlet extractor and examining them for nitro-glycerin by means of diphenylamine in sulphuric acid. The ether is then distilled up into the Soxhlet and run off by means of tap, the residue is dissolved in water and made up to 250 c.c., the aqueous Soxhlet and ether washings being also added to the solution.

Fifty c.c. of the solution are transferred to the flask of the reduction apparatus, which consists of a flask fitted with a splash head to which is attached a reflux condenser, absorption flasks containing N/10 acid being attached to the condenser. 50 grms. of a mixture of powdered zinc (2 parts) and reduced iron (1 part) are added, together with 50 c.c. of 40 per cent caustic soda solution, and the ammonia distilled off in a slow current of air and collected in standard acid (about 75 c.c. N/10 acid) in the absorption flasks. The excess of acid is then titrated back. 1 c.c. of N/10 acid corresponds to 0·00757 grm. of nitro-glycerin.

The examples given in Table II., which show the nitrogen present as nitro-glycerin, will serve to illustrate the degree

* To be obtained of Messrs. Townson and Mercer, 34, Camomile Street, E.C., or Messrs. Muller, 6, Orange Street, Red Lion Square

TABLE I.—*Experiments on the Quantitative Estimation of Nitro-glycerin in Ethereal Solution.*

| Conditions of experiment. | Percentage of the nitro-glycerin taken found by experiment. | Molecular proportion of reagent per molecule of nitro-glycerin taken. | Remarks. |
|---|---|---|---|
| I. Saponification by boiling the ethereal solution with alcoholic caustic soda. | | | The reaction was hardly complete after twenty-four hours' boiling (*b*). Ammonia was evolved, and in three cases estimated :— (1) 1·39, (2) 1·65, (3) 2·09 Per cent of the total nitrogen present was evolved as ammonia. |
| 1. Product titrated unfiltered.. | 86·35 (*a*) | 4·32 NaOH | |
| 2. " " .. | 86·48 (*a*) | 4·32 NaOH | |
| 3. Product filtered .. .. .. | 88·46 (*a*) | 4·42 NaOH | |
| 4. " " .. .. .. | 89·10 (*a*) | 4·45 NaOH | |
| II. Saponification by boiling the ethereal solution with alcoholic caustic potash for twenty-eight hours. | | | |
| 1. Product titrated unfiltered.. | 84·65 (*a*) | 4·23 KOH | |
| 2. " " .. | 85·10 (*a*) | 4·25 KOH | |
| III. Saponification by heating the ethereal solution with alcoholic caustic potash in a sealed tube. | | | |
| 1. For six hours at 100° C. .. | 81·75 (*a*) | 4·09 KOH | |
| IV. Saponification by warming the ethereal solution with sodium ethylate. | | | The reaction proceeds much more readily than in the above cases, being fully completed in six hours. Ammonia was evolved and estimated in two cases :— (1) 1·05, (2) 0·61 Per cent of the total nitrogen present was evolved as ammonia. |
| 1. .. .. .. .. .. .. | 86·16 (*a*) | 4·31 $C_2H_5ONa$ | |
| 2. .. .. .. .. .. .. | 86·53 (*a*) | 4·33 $C_2H_5ONa$ | |
| V. Saponified by heating the ethereal solution with alcoholic ammonia in a sealed tube. | | | The reaction is obviously incomplete, as at least three molecules of ammonia must be required. |
| 1. For six hours to 100° C. .. | — | 1·88 $NH_3$ | |
| VI. Reduction of ethereal solution to ammonia by means of a copper-zinc couple. | | | Traces of unchanged nitro-glycerin could still be detected in the flask after prolonged boiling. |
| 1. In alkaline solution .. .. | 69·51 | — | |
| 2. In acid solution .. .. .. | 54·26 | — | |
| VII. Reduction of ethereal solution to ammonia with zinc-dust and sulphuric acid in presence of salicylic acid. | | | Reaction violent and altogether unsuited for quantitative work. Results are therefore not included. |
| 1. .. .. .. .. .. .. | — | — | |
| 2. .. .. .. .. .. .. | — | — | |
| VIII. Reduction to ammonia by boiling ethereal solution with tin and hydrochloric acid. | | | Reduction was carried on for three hours. |
| 1. .. .. .. .. .. .. | 66·39 | — | |
| IX. Reduction to ammonia by heating ethereal solution with stannous chloride and hydrochloric acid; excess of stannous chloride estimated by titration with one-tenth normal iodine solution. | | | In all cases the quantity of stannous chloride used is insufficient to account for the reduction of all the nitro-glycerin present. |
| 1. At boiling-point of ethereal solution.. .. .. .. | — | 5·63 $SnCl_2$ | |
| 2. | — | 6·40 $SnCl_2$ | |
| 3. For six hours at 100° in sealed tube .. .. .. | — | 9·76 $SnCl_2$ | |
| 4. | 88·35 | 9·76 $SnCl_2$ | |
| 5. | 81·49 | 9·66 $SnCl_2$ | |

(*a*) These figures are calculated on the generally accepted equation for the saponification of nitro-glycerin, according to which one molecule of this substance requires five molecules of alkali.

(*b*) In aqueous solution the saponification is far slower and less complete, whilst the presence of alcohol prohibits the use of hydrogen peroxide. The method recently published for the estimation of nitrogen in nitro-cellulose (M. Busch, *Ber.*, 1906, xxxix., 1401) is therefore not applicable.

TABLE I. (*continued*).

| Conditions of experiment. | Percentage of the nitro-glycerin taken found by experiment. | Molecular proportion of reagent per molecule of nitro-glycerin taken. | Remarks. |
|---|---|---|---|
| X. Reduction of ethereal solution to nitric oxide by boiling with ferrous sulphate and sulphuric acid. | | | The nitric oxide was mixed with excess of air, the nitric peroxide produced collected in standard caustic soda solution, and the excess of alkali titrated with N/10 acid. It was found impossible to bring about the completion of the reaction even after prolonged boiling, whilst unchanged nitro-glycerin invariably found its way into the absorption flask. |
| 1. .. .. .. .. .. .. | 34·60 | — | |
| XI. Estimation of nitro-glycerin as ammonia produced by the reduction of its saponification products with zinc, iron, and caustic soda. | | | Calculated to nitrogen, this is— |
| 1. .. .. .. .. .. .. | 100·18 | — | 18·53 per cent. They require 18·50. |
| 2. .. .. .. .. .. .. | 99·43 | — | 18·39 " |
| 3. .. .. .. .. .. .. | 99·78 | — | 18·46 " |

TABLE II.

| Explosive. | Nitrogen determinations by Dumas' method. | | | Nitrogen present as nitro-glycerin. | |
|---|---|---|---|---|---|
| | Nitrogen in original cordite, &c. | Nitrogen in extracted nitro-cellulose. | Percentage of nitro-cellulose. | Calculated from results by Dumas' method. | Found by new method. |
| Experimental cordite, F. 140 .. | 14·77 | 12·82 | 36·33 | 10·11 | 10·02 |
| Experimental cordite. 4296 .. | 15·53 | 13·22 | 31·83 | 11·32 | 11·35 |
| Experimental cordite, 2614 .. | 13·90 | 12·85 | 65·43 | 5·49 | 5·47 |
| Blasting gelatin .. .. .. .. | 17·21 | 11·81 | 8·26 | 16·24 | 16·00 |

of accuracy of the method. Nitrogen estimations were also carried out by Dumas' ultimate method on the original explosive, and also on the nitro-cellulose separated by ether extraction, and the nitrogen present as nitro-glycerin, calculated from these data, is given for comparison.

The slight discrepancy between the two results when applied to blasting jelly is due to the fact that Dumas' method invariably gives high results when applied to this explosive; the new method is evidently accurate in this case also.

Our thanks are due to the Director of Artillery and the Explosives Committee for permission to publish these results.

Research Laboratories, Royal Arsenal, Woolwich.

## ABSTRACT JOURNAL.

We have received the following communication from Dr. William A. Noyes, Secretary of the American Chemical Society:—

Last year the question of raising the dues of the American Chemical Society to eight dollars for the purpose of publishing an Abstract Journal, in co-operation with the Society of Chemical Industry and the London Chemical Society, in case such co-operation could be secured, was submitted to a vote of the members of the American Chemical Society. About 85 per cent of those voting expressed their willingness to increase the dues for this purpose.

A conference with members of the Society of Chemical Industry and of the London Chemical Society was held in the rooms of the latter Society at Burlington House, London, on Friday, July 14, 1905. There were present: Dr. E. Divers, Mr. Watson Smith, and Dr. L. W. Thorne, representing the Society of Chemical Industry, and Prof. Raphael Meldola, Prof. W. A. Tilden, Dr. Alexander Scott, Prof. M. O. Forster, Prof. Sir William Ramsay, Mr. A. J. Greenaway, and Prof. H. E. Armstrong, representing the London Chemical Society. Dr. Hugh Marshall came from Edinburgh in place of Dr. Leonard Dobbin, a member of our committee who could not be present. The editor of our Journal, Dr. W. A. Noyes, presented the matter for the American Chemical Society. In the discussion which followed representatives of the Society of Chemical Industry expressed the opinion that the difficulties in the way of co-operation were too great. Prof. Ramsay and Prof. Armstrong spoke in favour of co-operation, while Prof. Tilden and Dr. Scott feared that joint publication of abstracts would result in loss of membership to the London Chemical Society. In general, those present seemed to agree that co-operation is very desirable, but the difficulties appeared to the majority as almost insuperable.

After further very careful study of the problems, I submitted to the three societies a plan for co-operation in which it was proposed that each society should prepare abstracts essentially as at present, eliminating duplication of abstracts and collecting all of the abstracts prepared by each society for publication in a single journal. A careful estimate was made of the cost of such a publication and the statistics of membership were carefully gathered. It was shown that about 80 per cent of the individuals belonging to the three societies receive at present only one of the Journals. It was shown, further, that by increasing our dues to eight dollars and increasing the dues of the Society of Chemical Industry to thirty shillings, instead of twenty-five, it would be possible to furnish an Abstract Journal which would combine all that is of value now published by the three societies, into a single Journal, and send this to every member of each society. In reply to this proposition the Society of Chemical Industry decided that it could not take part in such a co-operation. A similar co-operation between our Society and the London Chemical Society seems impossible for the reason that that society is

unwilling to publish abstracts in technical chemistry. An attempt to secure an exchange of abstracts between our own Society and the London Chemical Society on some equitable financial basis has also failed.

In consideration of the desire for a complete Abstract Journal expressed by so many of our members, it seems right for us now to consider the feasibility of publishing such a Journal for ourselves. It is evidently impossible for us to publish at once as complete a Journal as might have been published by co-operation between the three societies. It is estimated, however, that if we ncrease the dues to eight dollars, and there is no loss in membership, it will be possible to publish twice a month an abstract Journal of from 75 to 90 pages in each number, these pages to contain printed matter 11½ by 18½ c.m., set in eight point type. This would contain an amount of material corresponding to about three thousand pages annually of our present Review of American Chemical Research, and would be a larger amount of material than is furnished in the way of abstracts by either the Society of Chemical Industry or the London Chemical Society.

In this Journal it is proposed to include, as far as possible, abstracts of all important articles upon chemistry published in the world. In order to bring the material within the space prescribed it will be necessary to make the abstracts in organic and physical chemistry very brief, while it is proposed to give somewhat fuller abstracts in other fields, especially in analytical chemistry and in articles pertaining to industrial processes. If it proves possible to maintain the Society at its present membership and rate of increase, it is believed that in a comparatively few years we can increase the length of abstracts in those fields where at first they are especially abbreviated and furnish an Abstract Journal which will be satisfactory to all classes of chemists.

It is proposed to issue the first number of the Journal on January 1, 1907.

In order to undertake the publication of the new Journal it will be necessary to make two changes in the constitution of our Society and two changes in the by-laws. These changes were proposed at the Ithaca meeting, referred to a committee of the Society composed of Drs. J. H. Long, William McMurtrie, and W. A. Noyes, and on approval by the committee were approved by the Council and referred to the Society with the recommendation that the changes be adopted. Please vote on these amendments by means of the postal card which is enclosed.

In case the Society approves of the publication of the new Journal, and votes to increase the dues for this purpose, the hearty co-operation of all our members in an endeavour to prevent the loss of members because of the increase of dues and in the endeavour to secure new members, will be very important. The undertaking which lies before us is a large one and we believe one which is of very great importance not only to ourselves and to the English-speaking chemists of the world, but also to the growth of the science of chemistry.

It is most earnestly desired that every member of the Society shall vote on this question.

## CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxliii., No. 2, July 9, 1906.

**Chlorides and Sulphates of Rubidium and Cæsium.**—M. de Forcrand.—The author investigates the thermochemistry of the chlorides and sulphates of rubidium and cæsium.

**Secondary Alcohols of Dichotomic Octane, $(H_3C)_2$—CH—$(CH_2)_4$—$CH_3$.**—Louis Henry.—The replacing of hydrogen by OH in the $CH_2$ of the normal carbon chains, $CH_3$—$(CH_2)_n$—$CH_3$, has only a very slight influence on the volatility of the corresponding secondary alcohols. The author finds that the boiling-points of these alcohols rise in proportion as their component —CH(OH) is further removed in the molecule from the dichotomic radicle, $\begin{matrix}H_3C\\H_3C\end{matrix}>CH$.

**Action of the Electric Current on Cyanogen.**—H. Gaudechon.—When an electric current acts on perfectly pure dry cyanogen, a body is formed which does not result from the products of the simple polymerisation of cyanogen, but from the solid and soluble products of condensation (rich in carbon) formed during the simultaneous elimination of nitrogen gas. The composition of this product varies with the pressure of the gas, electric capacity of the apparatus, &c. The author describes his apparatus, and finds that the resulting brown body is partially soluble in water and alcohol and totally soluble in dilute alkaline solutions, showing that it cannot contain any free carbon.

**Decomposition of Acid Amido-derivatives of Albumins.**—Albert Morel.—By introducing, either together or separately, leucine and tyrosine into the molecule of urea the author prepares the following substituted ureas of glycocoll :—(1) Isocyanate of ethyl glycocoll, $CONCH_2.COOC_2H_5$; (2) urea of glycocoll or carbamido-acetic acid, $CO<\begin{matrix}NH.CH_2COOH\\NH.CH_2COOH\end{matrix}$; (3) mixed urea of glycocoll and leucine, $CO<\begin{matrix}NH.CH_2.COOH\\NH.\underset{\underset{COOH}{|}}{CH}.CH_2.CH<\begin{matrix}CH_3\\CH_3\end{matrix}\end{matrix}$; (4) mixed urea of glycocoll and tyrosine, $CO<\begin{matrix}NH.CH_2.COOH\\NH.\underset{\underset{COOH}{|}}{CH}.CH_2.C_6H_4OH\end{matrix}$. He also investigates the action of digestive ferments, such as pepsine and pancreatic juice, on ureas and amido-acids.

**Condensations with Anthranol.**—R. Padova.—The author succeeds in obtaining in the anthracene series a body, corresponding to the diphenylquinomethane of Bisztrizky and Herbst in the benzenic series, which he designates diphenylanthraquinonemethane or diphenylmethyleneanthraquinone.

**Reduction of Non-saturated Primary Alcohols of the Fatty Series by Ammonium Metals.**—E. Chablay.—The author's experiments show that the ammonium metals can give with non-saturated alcohols interesting reduction reactions, the hydroxyl (OH) being replaced by an atom of hydrogen. He also examines a certain number of these reactions on other non-saturated alcohols of the fatty and aromatic series. The hydrogenation is due to the formation of an alcoholate, the alkaline metal only taking part in the reaction, and there being no transformation into amide as in the case of the halogen derivatives of the carbides. This fact also led the author to study the action of the alkaline metals on alcohols, and he finds that the same reactions take place, but with less intensity. Thus allylic alcohol, when treated with sodium, gives a mixture of hydrogen and propylene, whilst sod-ammonium only gives propylene.

**Transformation of certain Secondary and Tertiary α-Glycols into Ketones, and Transposition of Hydrobenzoin.**—MM. Tiffeneau and Dorlencourt.—In order that the transformations of bi-secondary or secondary-tertiary α-glycols into acetones shall be accompanied by molecular migrations, it is not enough that the intermediate alcohol formed possess an aromatic radical attached to its oxyhydride, but it is also necessary that the transitory alcohol function is not a vinylic function, as in compounds of the form ArC(OH) = CRR′. The transposition of hydrobenzoin approaches in a general manner that of the aromatic iodohydrines, but it constitutes an isolated case amongst the glycols.

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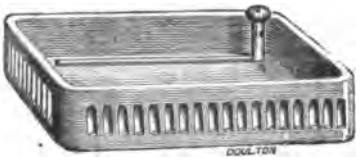

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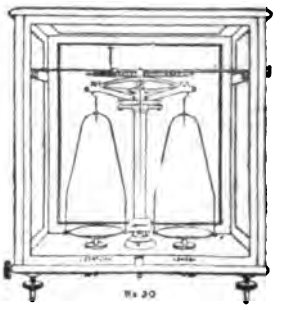

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THE CHEMICAL NEWS.

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## THE EVOLUTION OF THE ELEMENTS.*

By F. SODDY.

The subject chosen for the discussion which I have been asked to open is almost as old as any in philosophy, but the profound change which it has undergone in the last decade makes it desirable to pause, and, looking backward, to review the standpoint that has been attained. I shall attempt to deal briefly with the historical aspect, in the hope of showing how perfectly the newer ideas dovetail into, and arise naturally out of, the hardly-won articles of scientific belief of a generation ago. The new emphatically does not in any sense subvert the old, but the horizon has greatly extended—how greatly is perhaps hardly yet fully admitted. Facts always remain in modern science, and theories, too, in so far as they mirror them completely. So the old facts about the atom and element remain; but the theories, which are the generalised expression of all the facts, have had—in connection with the discovery of radioactivity—to accommodate some new facts of a strange, not to say revolutionary, character. The extension of the theories which have been rendered necessary has not been revolutionary in any distinctive sense. It is wonderful how accommodating a true theory is to new truth apparently of a diametrically opposite character; and this, not in any sense of mere ingenuity of explanation, but in a manner that arrests the investigator, and is his sign that he is on safe ground. From the very first the best proof of the newer views, to my mind, was in the completeness with which the strange newly-won knowledge harmonised with the old, and gave to it a still deeper meaning.

I intend first to consider the distinguishing features of the newer conception of the evolution of the elements, and how it came about that they remained so long unanticipated either in imagination or discovery. Then the new light that has been shed on some of the oldest problems in the more speculative departments of knowledge must be touched on, and this leads naturally to the question as to what are the limitations of the present position. How far does the new view fail to reveal types of evolution which now may be legitimately imagined to be taking place, and of which the only thing we are certain of is that our present weapons are unequal to the task either of discovering or investigating them? Again we have to take in account the poverty of the unaided human imagination and the wealth of suggestion that one fundamentally new point of view awakens. From this point of view it is the advance made that points to an extension of possibilities so great as almost to amount to a revolution of thought; possibilities of the ultimate convergence of these newly-discovered processes and activities of matter on the practical problems of life and the future welfare of the race, which, considered in the light of the known effect of the relatively insignificant forces which have already been harnessed and are taking every day a larger place in our lives, lose none of their suggestiveness for being so vague and incalculable; possibilities of a new order of things—a more extended and exalted material destiny than any that have before transpired, even as possibilities must affect the imagination and lay hold on the thought of the future, none the less even if they continue to remain out of reach. It is in this sense that the new discoveries must affect in time the whole trend of philosophic thought. We are now, however, more nearly concerned with the lines of attack at our disposal for dealing with the new situation which has presented itself, and in which it must be confessed we feel unusually ill-equipped. The weapons available are rather limited in their range, and there is the possibility that the radio-elements may remain for long the only example of a process of evolution which we cannot but believe will ultimately embrace all the elements within its scope, and lead to a consistent theory of the whole material universe.

More than fifteen hundred years ago, as M. Berthelot has pointed out, the symbol by which matter was everywhere expressed was a serpent, the body coiled into a circle and the head devouring the tail, bearing the central motto "ἐν το παν." This was derived from the Greeks, who, in imagination untrammelled by knowledge, far surpassed even the most advanced theory of to-day, supposing that material evolution proceeded in a cycle, and thus were able to arrive intuitively at a system at once continuous, consistent, and eternal, avoiding the inherent difficulties connected with the beginning and end of the process which trouble us to-day. From that time till quite recently, although the idea of continuous evolution of matter was never absent, experimental knowledge advanced steadily along lines which seemed almost to disprove the possibility of any such process. We had Boyle's recognition of an element as a substance which could not be fundamentally changed or made to yield anything more simple, and the continued existence of a relatively few constituent elements throughout all chemical changes. The Law of Multiple Proportions and Dalton's Atomic Theory led to the idea of atoms in their modern experimental sense as the units of all chemical changes—the bricks, so to speak, out of which all molecules are built and into which they can be resolved. The advent of the spectroscope, and the evidence afforded by such meteorites as make their way to us from distant regions, proved the essential uniformity of material composition of the whole universe.

Intimately connected with these researches, another idea took shape as chemistry advanced. Not the slightest variation in the properties of elements could be detected, and hence each atom of any one element must be exactly like every other. It had constants, such as the atomic mass, which is in itself a theoretical abstraction from the experimental combining or equivalent weight, and periods represented by the characteristic lines in its spectrum, capable of being measured with extreme accuracy, and in which the slightest variation in value had never been detected. An atom of hydrogen executes its vibrations by which we know it at precisely the same rate in the most distant star as in the laboratory. This seemed to exclude the possibility of a gradual change or evolution of one element into another. The position cannot be more forcibly expressed than in the familiar words of Clerk Maxwell to this Association at the Bradford meeting in 1873:—

"In the heavens we discover by their light, and by their light alone, stars so distant from each other that no material thing can ever have passed between them, and yet this light tells us also that each of them is built up of atoms* of the same kind as those we find on earth.

"Each atom, therefore, throughout the universe bears impressed upon it the stamp of a metric system as distinctly as does the metre of the Archives of Paris or the double royal cubit of the temple of Karnac. No theory of evolution can be formed to account for the similarity of atoms, for evolution necessarily implies continuous change, and the atom is incapable of growth or decay, of generation or destruction.

"On the other hand, the exact equality of each atom gives to it, as Sir John Herschel has well said, the essential character of a manufactured article, and precludes the idea of its being eternal and self-existent."

In this quotation we have the best generalised expression of the philosophy of a generation ago. To-day we

* A Paper read before the British Association (Section A), York Meeting, 1906.

* I have replaced the word "molecule" throughout by "atom," so as to retain the same meaning for the word atom as it bears throughout the paper.

could deduce even more striking examples of the exact similarity of atoms than were then known, and yet we believe in evolution as an experimentally demonstrated fact.

A little later the swing of the pendulum was again towards some system of evolution. The discovery of the Periodic Law, and the natural order into which the elements fell when classed according to their atomic weight, the recurrence periodically of elements resembling each other in properties, these resemblances extending even to similarity of spectrum, together with the growing knowledge of all that the spectrum of an element implied, led to the view that similar elements must possess similar structures in which the constituent stuff out of which they are built is the same, but the quantity and arrangement different in the formation of each atom. The idea was expressed by the lemniscate curve of Sir William Crookes, that the elements were successively formed out of the same protyle, while in their formation a periodic change of the conditions conditioned the periodic recurrence of properties. A little later Sir Norman Lockyer propounded a theory of inorganic evolution accompanying the cosmical evolution, in which in the hottest stars it was concluded the conditions are such that only the lighter elements can exist, and then as the star cools the heavier elements successively make their appearance by the condensation of the lighter.

Finally we have the brilliant series of researches emanating from the Cavendish Laboratory under J. J. Thomson, in which he succeeded in the isolation and measurement of the constants of the corpuscle or negative electron, and the recognition that this must possess the fundamental attribute of matter, inertia or mass. From this point came the step to the conclusion that negative electricity might be the protyle, out of which all atoms are in some way constructed, by varying numbers being combined together in stable systems in regular motion. But into the more purely speculative part of this theory it is not necessary for me to venture.

I pass to the discovery of the radio-activity of matter by Becquerel and its essential characteristic which at once arrested attention. Here we had a case of certain of the heaviest elements being proved continually to liberate energy of a very novel and striking character, without at first sight any perceptible change in the matter or any exhaustion of the supply. As is well known, this energy is manifested in the emission of new sorts of radiation, and it has been proved that these radiations are in nature much what Newton supposed light to be, consisting of streams of material particles ejected from the matter with hitherto unknown velocities. In general two kinds of radiant particle have been recognised, the $\alpha$-particle having a mass slightly greater than the hydrogen atom, and the $\beta$-particle, which is an electron or corpuscle, many thousand times smaller.

A theory elucidating the mystery was worked out in the laboratories of McGill University, Montreal, under Rutherford, four years ago, and having proved itself adequate to explain the known facts and to suggest innumerable new discoveries, it has received general acceptance. I need only recall the discussion which took place on the subject in this section three years ago, which assisted materially in the favourable reception accorded it, and in this section at least I need only briefly refer to its main outlines.

The atoms, in the case of the radio-active elements, are spontaneously breaking up into atoms of lighter elements, and this change proceeds in each case according to a very simple law. The same definite fraction of the total number of atoms breaks up in the unit of time in the case of any one radio-active element. The $\alpha$-particle expelled with enormous velocity consists, as we have seen, of an atom a little heavier in mass than the hydrogen atom, and this it seems probable, though it has not been completely proved, is an atom of helium. The residual atom which is left in many cases breaks up again and again, more $\alpha$ or $\beta$ particles being expelled, the same law as before being followed, only in the succeeding products the fraction changing in unit time is usually much larger than in the original elements, so that the consequence is that these products have a very limited term of existence, and can only accumulate in minute quantities. The energy that is evolved in this change is so enormous that very slow changes can be observed, where the actual amount changing is so infinitesimal that it is hopeless to attempt to detect it by ordinary methods. This appears at once when it is considered that the smallest quantity of any element that can be detected by the spectroscope contains $10^{10}$ individual atoms, whereas the disintegration of a single atom accompanied with the expulsion of one $\alpha$-particle is not greatly, if at all, below the limit of detection by present methods.

At first put forward on radio-active evidence alone, it was not long before additional evidence of the correctness of the view was obtained by the older methods. With the discovery in the laboratories of the University College, London, under Sir William Ramsay, of the production of helium from radium, the fact of the gradual evolution of one element into others passed beyond doubt, and the new methods of investigation received the support of the old in a case where it was found possible to examine the process from both points of view.

The essential features distinguishing the type of evolution revealed by radio-active processes from previous conceptions chiefly claim our attention.

The first consists in the reconciliation of the idea of a gradual evolution of one element from another with the facts of chemistry and spectroscopy which we have seen were at one time interpreted to prove the exact opposite. On the new view the change, though of any degree of slowness so far as the mass of the matter is concerned, is sudden and abrupt for each individual atom. There is no gradual alteration of one element in properties until it changes into another, but an abrupt, or more usually a series of abrupt, step-by-step changes in property accompanying the sudden expulsion of the $\alpha$-particle. As great a difference exists between radium and its emanation, which is its first product, as between any pair of elements known. Yet it is gradual in the sense that only a small fraction of the total quantity of the radium changes in each unit of time.

Slight as this addition is to make the requirements of chemistry and spectroscopy conform to that of continuous evolution, yet the words of Maxwell clearly show how small a step the most brilliant imagination unaided is able to take. It would be an interesting digression to examine the small part played by the imagination, unaided by existing models or analogies, in mathematical and physical science.

The second distinguishing feature is that the evolution proceeds from the complex to the simple. In all previous ideas a continuous building up of the original protyle into something more and more complex was imagined.

The third difference is that the evolution is actually proceeding under our eyes, instead of having once proceeded in the remote past, or if proceeding now, then only under transcendental conditions impossible to realise in the laboratory, which was the earlier idea.

But the fourth distinguishing feature is the vital one. Hitherto the energy change that must accompany a subatomic change had received no consideration, while in the new views it is the dominating aspect. Much takes on a new significance in this light. We have seen how the range of the older weapons of investigation, the balance and the spectroscope, have been left behind. We can understand why it is that these new changes proceed with such complete independence of their environment. All the forms of energy known previously are of such a much lower order of magnitude that it is not to be expected that we should be able to influence the rate of change with the means at our disposal. The explanation is now ready to hand why the elements have hitherto resisted and still resist all attempts to change them. The resistless energy which accompanies the break up of an atom must pre-

exist within the atom and be controlling its history, making it independent of its environment and such forces as we can bring to bear upon it from the outside. For the first time we have a positive proof, if such were needed, of the correctness of the stand taken by chemistry against the claim of the alchemist. There may have existed a lingering doubt in some minds after reading the circumstantial accounts that have been recorded of actual transmutation, that perhaps in some cases the alchemist by chance achieved his ends. Now, however, we know that such could certainly not have been the case on account of the energy which would have been evolved in the change of a heavy element into a lighter one, or absorbed in the reverse process. On the other hand, we can imagine what consequences the successful transmutation of metals would bring in its train, which are not at all those which its devotees have imagined. In this problem our position might be compared to that of the savage who knew something of fire and its possibilities, and yet neither possessed it nor could start or control it. The control and utilisation of fire and other sources of energy means no more to the present than the control and utilisation of the internal energy of matter will mean to the future, if ever it comes to be accomplished.

It is in this aspect also that the most revolutionary changes in previous ideas are rendered necessary. The energy changes accompanying any form of continuous material evolution must be the controlling factor in any cosmical scheme, and the failure to recognise this so deeply affects all the existing views on cosmical and terrestrial evolution that it is difficult to see what will remain when it is rectified. But a beginning has been made, and the discussion that has been arranged in this section must bring forth fruit abundantly. I need only say I would like to see the whole subject reconsidered, now that it is clear that an isolated body in space need not of necessity get cooler although continually losing heat.

There is a small question of nomenclature, the use of the word *atom* now that atoms have been shown to be changeable, which may appear justified if we consider the history of the word. The Greek meaning conveyed by the word was purely an imaginative one, being in fact the smallest particle of matter that can be imagined. From the time of Dalton a new experimental meaning became attached to the word, to signify the smallest part of an element, or the unit, that enters into chemical change, and since chemical changes were the most fundamental then known, the word signified in a derived sense the smallest particle that can exist. To-day the atom still retains the exact meaning it has had for a century, as the unit of chemical change; but chemical change is not now the most fundamental known. Radio-active change is so utterly different that it cannot be considered to have any relation to chemical change.

The view has been expressed to me that since the radio-elements have been shown to undergo changes it is incorrect any longer to speak of their atoms, and the word molecules would meet the case. But this would cause the word *atom* to drop out of scientific use altogether, for no element is safe from the fate which has shown to overtake the radio-elements. On the other hand, if we used the word molecule throughout where now we use atom, and spoke of a molecule of hydrogen where now we mean atom, we should have to revive the old clumsy nomenclature of simple molecules meaning atoms, and compound molecules meaning molecules.

*Limitation of Present Methods.*—Our knowledge of material evolution has arisen almost entirely on account of the energy emitted in the processes, the material evidence, as in the proof of the production of helium from radium, being of necessity only confined to a few cases. The general condition which determines whether any process of spontaneous evolution comes within our experimental methods of detection is simply that the energy evolved should be sufficient in quantity and suitable in kind. There is no doubt that in the actual case of the radio-active elements the conditions are exceptionally favourable. Probably in no other branch of physics can such a minute evolution of energy be detected and accurately measured as in radio-activity. The electroscope is the oldest and simplest, as it is the most sensitive electrical instrument, and in proper hands possesses possibilities for accurate measurement by no means to be despised. It may seem to conflict with what has been said as to the enormous quantities of energy liberated during radio-active processes that such delicate methods should be demanded, but that is because the actual amount of matter changing is always infinitesimal, even under the most favourable circumstances.

Since the theory of atomic disintegration was advanced it has become more and more plain that such disintegration may and does occur without the accompaniment of radio-activity. We now rather regard radio-activity as a gratuitous hint given us, one might almost say overlooked, by Nature into secrets we were not bound ever to have known of at all. For the same result and the same type of evolution could have been accomplished and may actually be going on without our possessing any means to discover or investigate it. Three separate lines of evidence which have lately transpired show this in the clearest possible manner. In the first place Rutherford proved the existence of changes in the disintegration series of radium, thorium, and actinium, in which no detectable radiation was expelled. Let A change into B, and B into C, and C into D. The middle change of B into C might be a "rayless" change, but it would still be possible to detect it so long as detectable radiation were expelled from A and C. The same point may be illustrated also by a slightly different case taken from an investigation four years ago in a series where some of the changes only emit $\alpha$-rays, and others both $\alpha$ and $\beta$ rays. If some of the radium emanation, which emits $\alpha$ but not $\beta$-rays, is put into a vessel with thin walls, capable of absorbing completely the $\alpha$-radiation and allowing the $\beta$-radiation to pass through, no external radiation can be detected from the vessel when the emanation is first introduced. Little by little as the emanation begins to change an external radiation makes its appearance and gradually grows. If now the emanation is blown out of the vessel, the products of its change, being solid, are left behind deposited on the inside walls. The external radiation is not at all affected, but as time goes on gradually decays away. It would not have made any difference to the above experiment if the emanation had not given out rays. Its existence could have been inferred from its producing a body which did give out rays, and moreover the rate of its change into this body could be determined. In this way Rutherford has established that changes occur without the emission of a detectable amount of energy, but which are nevertheless demonstrable because they are preceded and followed by changes in which detectable energy is given out.

In the next place the past two years' work on the nature of the $\alpha$-ray has shown clearly that it is only detectable within somewhat narrow limits of velocity. If we represent the velocity of the fastest moving $\alpha$-particle expelled from radium by 100, then it has been shown that an $\alpha$-particle moving with a velocity below 60 would fail to be detected by all our methods, electrical, photographic, or phosphorescent. The identical $\alpha$-particle we know, through radio-active tests, might be expelled with a velocity up to 10,000 miles a second, and we should be unaware of it and incapable of detecting it by its energy.

Lastly, the possibility remains to be considered that such a particle might be detectable by its charge. I need only mention the ingenious contrivance of Strutt, popularly known as the radium clock, to illustrate a possible method. This detects the loss by radium of negative electricity carried away by the negatively-charged $\beta$-particles. In the same way it might be thought that an otherwise undetectable $\alpha$-radiation might be detected by the loss of positive electricity. This hope, however, proves illusory.

There are theoretical grounds which made me suspect that the positive charge carried by the α-particle is an accident of the conditions under which it was examined, and that the α-particle is not charged when initially expelled from the atom. This I have now proved to be the case, and so far as we can see, if its energy was below that at which it could be detected, the α-particle never would become charged at all.

So that unless entirely new methods of investigation are discovered, we are forced back in the search for direct evidence of other processes of evolution on the purely material methods, such as the use of the spectroscope. Large quantities of materials are required; these materials are the more likely to be changing the rarer they are, which makes the research very costly, and in the end it is by no means certain that a single lifetime is long enough to give to the investigation to secure a positive result.

A possible research along these lines, which I started a year ago, but have not yet pushed very far owing to lack of time and material, is the examination of old coins, medals, and ornaments of undoubted antiquity, for evidence of occluded helium or similar gases. The age or date of manufacture of such articles can often be accurately fixed by the expert, and there is a tolerable certainty that the metals were melted during manufacture and have not been heated since. It seemed that if helium or other gas were found, a definite idea of the magnitude of the rate of change was arrived at as a preliminary to direct experiments. But a good deal of material is required, which need not necessarily have any great antiquarian value so long as its antiquity is above suspicion. An application for help to the British Museum failed, although individual officials have assisted me in the most generous manner from their own collections. But certainly the line of work looks promising enough to justify an attempt if the requisite quantity of material was forthcoming. In the meantime I have been engaged in a determination of the minimum quantity of helium and argon detectable by the spectroscope, and with some new methods find I can be sure of 1/2000 part of a cubic millimetre. This is by far the smallest quantity of any element that has with certainty been detected with the spectroscope.

Taking the possible methods in order of their directness and certainty, we come next to the method which has already given valuable evidence to prove that radium is being produced from uranium. If two elements can be shown to occur in constant relative quantity together in all cases in nature, this of itself is the strongest indirect evidence that the one is the parent of the other. The relative quantities of all the successive members of a disintegration series present with the parent element, attain with lapse of time a constant equilibrium value when as much of each is being formed as disappears in each unit of time. If the parent element is the longest lived member of the series, the relative amounts of each member, when the equilibrium state is reached, is inversely proportional to the relative rates of change, or directly proportional to the average life of each. Thus the researches of Strutt and Boltwood have proved that the amount of radium in all the natural uranium minerals is proportional to the quantity of uranium. This ratio is roughly one to a million, and represents the ratio of the life of radium to that of uranium.

The importance of this result is that it is not confined to radio-active changes. It is a simple deduction which holds good in any series of successive changes where the first change is the slowest, and each member changes into the next at a rate proportional to its quantity. If the rate of change of any member is rapid, the equilibrium amount that can accumulate is small; if the rate of change is slow, it will be large. Thus polonium, which is formed from radium, has never yet been obtained in quantities greater than the fraction of a milligrm., although many tons of pitchblende have been worked up for it. Half of it changes in 143 days, which is more than a thousand times faster than radium. Hence the activity is of the order of a thousand times greater, but correspondingly the quantity in pitchblende is of the order of a thousand times less than in the case of radium.

No other cases except those mentioned of two elements always occurring together in constant ratio in nature have as yet been proved, but if this is done it is as stated almost sufficient to prove that the rarer element has been formed from the one present in greater abundance, and is itself changing further into some other constituent of the natural mineral.

It remains to point out the limitations of this argument. No equilibrium state can be reached if the parent element is not the most stable of the series. If, for example, thorium were being produced from uranium, there could be no constant ratio between the quantities of uranium and thorium, for the rate of change of the thorium is five times slower than that of uranium, according to a recent accurate determination of Bragg. This limitation serves to show that the case is likely to be rare if the instability of the radio-elements, as is commonly supposed, is in some way connected with their heavy atomic weight.

We are thus led to consider constancy of association in nature apart from a constant ratio of quantity. This it will be rembered gave the necessary clue indicating helium as a disintegration product of radium.

These cases are common enough in chemistry, but little can be at present deduced from present knowledge. Tantalum and niobium are two inseparable companions in nature. Donald Murray has recently directed attention to the companionship of silver and lead in this connection, and examples could be multiplied. We are still in darkness as to whether there is any process complementary to disintegration, simultaneously building up the elements of heavier atomic weight, and maintaining their quantity, and this constant association in nature could result as well from a simultaneous formation of both elements as from the change of one into the other. Without other evidence no certain conclusion can yet be drawn in this field.

A slightly different phase of the same question is seen in an element having an approximate constant rarity in nature after prolonged and extensive search for it, I have drawn attention to the fact that the coinage metals, in particular gold, silver, and platinum, of necessity fulfil this condition more or less completely, indicating that these metals are likely subjects for a direct examination. I have already referred to the case of coins, where a direct examination is probably more likely to yield fruit than in any other case.

So far as the economic evidence goes, the scarcity of gold is a matter of concentration, like that of radium, for in small quantities it is like radium very widely distributed. Seeing that 500 tons of gold were produced last year the element can scarcely be scarce in any other sense of the word. It has the remarkable property of being found just whenever the demand for it increases, and the providential character of this behaviour makes me suspect that a law similar to that regulating the scarcity of radium was in question. If this turns out to be well-founded the theory of currency will be reduced to a branch of physics. We may anticipate a more scientific system of currency being devised than the present, which, in 1904, cost the world from fifty to a hundred million pounds value, thrown away in the unproductive labour of maintaining the gold and silver currency.

So far, only what may be termed passive lines of investigation have been considered where processes of spontaneous evolution are supposed to be taking place. There is no evidence whatever that any of the known processes can be in any way artificially influenced. If such were possible it would be tantamount to an artificial transmutation. But at least we know the lines along which even this more ambitious attempt might have a chance of success. The matter in question should be as minute in quantity and the energy acting upon it as intense as possible. These conditions are realised in the case of the residue of gas left in an X-ray bulb through which large amounts of electrical energy of great intensity are passed. The idea has long

been held that possibly in these bulbs the disappearance of the gas with use, resulting in the gradual improvement of the vacuum so well known to the X-ray operator, may be due to a real transmutation or resolution of the gas under the drastic treatment to which it is exposed. But no experiments have been published so far as I am aware along these lines, and the whole subject has not yet advanced beyond the speculative stage.

It remains to be seen whether the lines of investigation here sketched will bear fruit. With the problem of artificial transmutation is linked that of the ultimate utilisation of the internal energy of matter, the solution of which would alter our whole destiny. Its importance therefore cannot be questioned. But the magnitude of the problem is reflected in the difficulties which beset its investigation, and it may be that the single life of the individual and his limited resources will have to be replaced by an organised assault by institutions provided for the purpose, where continuity of purpose and large scale operations can be secured.

## PHOTOGRAPHS OF THIN LIQUID FILMS.*

By HERBERT STANSFIELD.

Mr. Stansfield, who is continuing in Manchester Professor Reinold and Sir Arthur W. Rücker's work on soap films, showed a number of photographs taken with a special camera which has been previously described (*Proc. Roy. Soc.*, 1906, A, lxxvii., 314). The photographs showed the thinning process of plane vertical soap films; at first, when the film is thick enough to show colours, the thinning takes place continuously, but when the thickness is reduced to about 100 $\mu\mu$ (1 $\mu\mu = 10^{-6}$ m.m.) there is a change in the conditions, and further thinning takes place by a series of abrupt steps. Films formed from solutions of sodium or potassium oleate in water pass through three distinct grey stages before they become black; the successive changes in thickness become more marked as the film becomes thinner.

Photographs were also shown of the last stage in the thinning process; the change from the black which is first formed to a thinner black probably only half as thick. Johonnott gives the thickness before and after this change as 12 and 6 $\mu\mu$ respectively. This phenomenon was observed by Newton, and is rather striking in the case of the sodium oleate films; the change was not so marked in the photographs of potassium oleate films, as some of the material removed in the reduction of thickness was left distributed as small specks in the thinner black.

In conclusion, photographs were exhibited showing effects produced by the separation of solid material in soap films.

## NOTE ON ERGOT ALKALOIDS.†

By G BARGER and F. H. CARR.

The crystalline alkaloid ergotinine was obtained from ergot by Tanret more than thirty years ago, and does not seem to have been studied chemically since then, no doubt owing to its extreme scarcity. Tanret assigned to ergotinine the formula $C_{35}H_{40}O_6N_4$, based on rather scanty analytical data; the molecular weight was deduced by analysis of the amorphous hydrobromide and hydrochloride of very doubtful purity.

We have been able to confirm Tanret's figures for the percentage of carbon and of hydrogen in ergotinine (roughly C = 68·5 per cent, H = 6·5 per cent), but find nearly 3 per cent more nitrogen (11·7 instead of 9 per cent).‡

Molecular weight determination in phenol solution by the cryoscopic method gave the values 477 and 516; in pyridine solution the value 463 was obtained, employing a microscopic vapour pressure method due to one of us (G.B.).

Without as yet definitely assigning a formula to ergotinine we suggest that the alkaloid probably has the composition $C_{28}H_{32}O_4N_4 = 488$.

It will be seen that the ergotinine molecule is not more complex than that of several well-known alkaloids, and that it is smaller than Tanret imagined. It is unique among alkaloids in having four nitrogen atoms.

Like Tanret, we have failed to prepare crystalline salts or other crystalline derivatives of ergotinine.

Ergotinine apparently contains no phenolic hydroxyl and no methoxy-group. It is probable that there is a methyl group attached to one of the nitrogen atoms. In methyl iodide solution a gelatinous methiodide is formed, and when one molecular proportion of bromine is added in chloroform solution, a hydrobromide, probably of monobrom-ergotinine, separates out.

From the ethereal mother-liquors of crystalline ergotinine Tanret obtained another non-crystalline alkaloid, which he termed amorphous ergotinine. A similar resinous substance of alkaloidal nature and great physiological activity was described by Kobert as cornutine.

We have now obtained the second alkaloid in a state of chemical purity, and suggest for it the name *ergotoxine*. Though itself amorphous it forms a number of crystalline salts. The oxalate crystallises from alcohol in minute prisms, mostly arranged in rosettes; the tartrate forms prisms; the phosphate fine needles, frequently grouped in sphaerites.

Unlike ergotinine, ergotoxine readily dissolves in aqueous caustic soda and gives a benzoyl derivative by the Schotten-Baumann method; it probably contains a phenolic hydroxyl.

The analytical data so far obtained point to a formula differing but slightly from that of ergotinine, and as both alkaloids occur in the same plant, it is probable that they are closely related chemically (as are, for instance, quinine and cinchonine).

Both alkaloids give strongly fluorescent solutions, and give with sulphuric acid and ferric chloride the play of colours originally described by Keller as characteristic of ergotinine.

According to the physiological experiments of Mr. H. H. Dale, ergotoxine produces in doses of a few milligrms. all the typical effects of ergot described by him in a recent paper (*Journ. of Physiology*, 1906, xxxiv., 163). There seems little doubt that it is the most important, if not the one essential active principle, whereas pure crystalline ergotinine is physiologically almost or quite inactive.

## ON THE TEMPERATURE AT WHICH WATER FREEZES IN SEALED TUBES.*

By Prof. H. A. MIERS, F.R.S., and Miss F. ISAAC.

The authors showed in 1905 that, in a cooling supersaturated solution in which a few crystals are growing while it is being stirred, the refractive index rises until, at a certain temperature, it attains a maximum value and then suddenly falls; at this moment also profuse crystallisation takes place. They concluded that this is the temperature of *spontaneous* crystallisation. The conclusion is confirmed by the fact that the same solution, enclosed in a sealed tube so as to be preserved from access of crystal germs, and protected from evaporation, crystallises in a shower at exactly this temperature.

The present experiments, 68 in number, were made with water contained in sealed tubes which were violently and

* Abstract of a Paper read before the British Association (Section A), York Meeting, 1906.

† Abstract of a Paper read before the British Association (Section B), York Meeting, 1906.

‡ We used Dumas' method; Tanret worked according to Will and Varrentrapp. We are indebted to Dr. P. Haas for two of the determinations, in which he proved the absence of methane in the residual nitrogen gas.

* Abstract of a Paper read before the British Association (Section B), York Meeting, 1906.

continuously shaken by hand in a bath of brine. The temperature of the brine was reduced by means of a tube coil through which the cold brine from a refrigerating machine was pumped; the brine in the bath was kept thoroughly stirred by a wooden horse-shoe shaped plunger perforated with holes. The rate of fall of temperature was about 2° an hour. Temperatures were read by a thermometer divided to one-tenth of a degree.

The water in the tube was either tap-water, or ordinary distilled water, or pure water of conductivity $1{\cdot}1 + 10^{-6}$, and filled about half the tube.

The initial temperature of the brine bath varied from +9° to −2°C.

The time occupied in each experiment varied from seventy minutes to five minutes.

The glass used was both ordinary glass tubing and Jena glass. Some of the tubes were made up just before the experiment; some had been made up weeks before.

All the tubes froze between −2° C. and −1·6° C.; the mean for all the experiments being −1·86° C., and for the pure water −1·9° C.

The ice generally makes its appearance at the bottom of the tube, and grows very rapidly, at first in star-like crystals, and then in a cloudy shower which spreads up through the tube.

The authors conclude that −1·9° C. is the temperature at which, under atmospheric pressure, pure water freezes spontaneously, *i.e.*, in the absence of solid particles of ice.

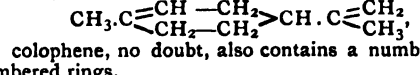
It is remarkable that this is also the temperature at which super-cooled water possesses a maximum refractive index, according to the observations of Pulfrich.

The effect of friction was studied by introducing glass, garnet, galena, or lead into the tubes; this caused the water to freeze at −0·4° C.

## NOTE ON THE POLYMERISATION OF ISOPRENE.*

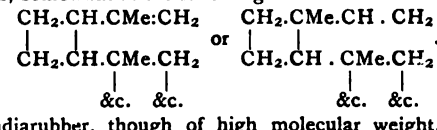
By Prof. W. A. TILDEN.

Many years ago I showed that the principal terpenes when decomposed by heat yield, among other products, a small quantity of isoprene, $C_5H_8$. The constitution of this compound has since been shown by Euler (*Ber.*, 1897, xxx., 1989) to be expressed by the formula $CH_2{:}CH.CMe{:}CH_2$. When kept for a long time isoprene is slowly converted into indiarubber, the process, however, occupying many years. The specimens now exhibited illustrate the process of transformation. If any attempt is made to hasten the operation, as by heat or contact with strong reagents, the greater part of the hydrocarbon is converted into dipentene, and the mixture of viscid compounds of high boiling-point, known as colophene, which results from the polymerisation of the terpenes. Dipentene has the formula—



and colophene, no doubt, also contains a number of six-membered rings.

It appears probable, therefore, that the slow polymerisation which ultimately results in the production of solid indiarubber is due to a different mode of linkage, leading to the formation of long chains. Except on the assumption of a shifting of hydrogen this can only take place on condition of the formation of a series of tetramethylene rings, somewhat in the following manner:—



Indiarubber, though of high molecular weight, is an unsaturated substance, as shown by the fact that it absorbs oxygen from the air and unites chemically with sulphur and other elements.

* Abstract of a Paper read before the British Association (Section B), York Meeting, 1906.

THE

## STUDY OF HYDRO-AROMATIC SUBSTANCES.*

1. *The supposed Identity of Dihydrolaurolene and Dihydroisolaurolene with* 1 : 1-*Dimethylhexahydrobenzene.*—In the last Report (1905, p. 153) brief allusion was made to the preparation of 1 : 1-dimethylhexahydrobenzene (Crossley and Renouf, *Journ. Chem. Soc.*, 1905, lxxxvii., 1487), and it was stated that the main object in view when preparing this hydrocarbon was a comparison of its properties with those of dihydrolaurolene and dihydroisolaurolene, with which hydrocarbons it has been supposed by Zelinsky and Lepeschkin to be identical (*Annalen*, 1901, cccxix., 303). This comparison has now been completed (Crossley and Renouf, *Journ. Chem. Soc.*, 1906, lxxxix., 26), with results which prove conclusively that neither dihydrolaurolene nor dihydroisolaurolene is identical with 1 : 1-dimethylhexahydrobenzene, as will be seen from the following summary of their properties:—

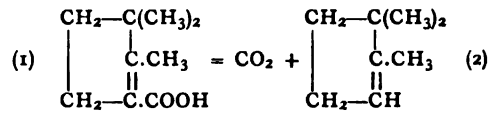
1 : 1-*Dimethylhexahydrobenzene.*—Boiling-point, 120°; specific gravity, 0·7864; odour, resembling geranium; oxidation product, ββ-dimethyladipic acid.

*Dihydrolaurolene.*—Boiling-point, 111·5—114°; specific gravity, 0·7633; odour, camphoraceous; oxidation product, oxalic acid.

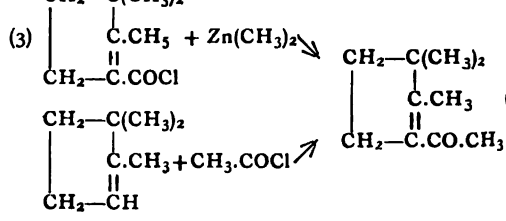
*Dihydroisolaurolene.*—Boiling-point, 113—113·5°; specific gravity, 0·7762; odour, sweet camphoraceous; oxidation product, αα-dimethylglutaric acid.

There is little to be said regarding the constitution of dihydrolaurolene on the present occasion, but it seems most probable that this substance is a mixture of hydrocarbons; whereas dihydroisolaurolene is proved by the following considerations to be a pentamethylene derivative.

In 1898 Blanc definitely established the constitution of isolaurolene in the following manner (*Bull. Soc. Chim.*, 1898, [3], xix., 699). Accepting his formula for isolauronolic acid (1) as correct, he believed isolaurolene to be represented by Formula 2.

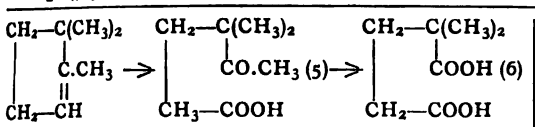


That is to say, that during the loss of carbon dioxide no change in the structure of the ring takes place. This was proved by the fact that isolauronolic chloride (3), when treated with zinc methide, gave rise to the same ketone (4) as is produced by the action of acetyl chloride on isolaurolene in presence of aluminium chloride:—



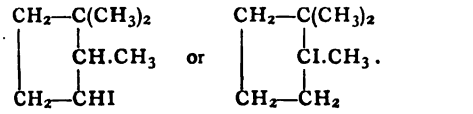
Blanc further showed that when isolaurolene was oxidised with potassium permanganate there was obtained γ-acetyldimethylbutyric acid (5), previously obtained by him from the oxidation of isolauronolic acid (*Bull. Soc. Chim.*, 1898, [3], xix., 533),—

* Report of the Committee, consisting of Dr. E. Divers (Chairman), Professor A. W. Crossley (Secretary), Professor W. H. Perkin, Dr. M. O. Forster, and Dr. H. R. Le Sueur. Read before the British Association (Section B), York Meeting, 1906.

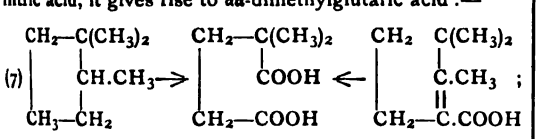


and this ketonic acid, on further oxidation, gave αα-dimethylglutaric acid (6). As Blanc says, the formation of γ-acetyldimethylbutyric acid by the oxidisation of isolaurolene shows that it can only have the constitution represented by Formula 2, and no other. Yet Zelinsky and Lepeschkin, in 1901, did not accept this conclusion, but regarded isolaurolene as a six-ring compound.

Accepting, then, Formula 2 for isolaurolene, the next step was to prove that when isolaurolene was treated with fuming hydriodic acid at a temperature of 120—125° no change in the nature of the ring was produced. For this purpose the hydriodide was treated with diethylaniline, when it readily lost the elements of hydrogen iodide, giving an unsaturated hydrocarbon, $C_8H_{14}$, boiling at 108—108·5°, and possessing properties identical with those of isolaurolene. In order that there should be no doubt on this point, the hydrocarbon was oxidised with potassium permanganate, when it yielded γ-acetyldimethylbutyric acid, and this, on further oxidation with sodium hypobromite, gave αα-dimethylglutaric acid. These are the same products as Blanc obtained by the oxidation of isolaurolene (see above), and conclusively prove that no isomeric change takes place during the production of the hydriodide, which must therefore have one of the following formulæ :—



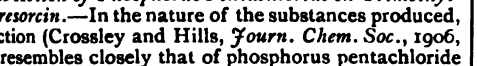
There is, moreover, no reason to suppose that heating this hydriodide with zinc dust in aqueous alcoholic solution would produce a change in the construction of the ring, and this is proved by the fact that when the resulting hydrocarbon (dihydroisolaurolene) is oxidised with diluted nitric acid, it gives rise to αα-dimethylglutaric acid :—

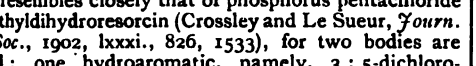


that is, to the same oxidation product as isolauronolic acid yields when treated with diluted nitric acid (*Bull. Soc. Chim.*, 1898, [3], xix., 284).

These experiments prove conclusively that dihydroisolaurolene is a pentamethylene derivative, and is 1 : 1 : 2-trimethylcyclopentane (7)—a deduction which receives striking confirmation from the magnetic rotation of dihydroisolaurolene, which has been determined by Dr. W. H. Perkin, sen.

2. *The Action of Phosphorus Pentachloride on Trimethyldihydroresorcin.*—In the nature of the substances produced, this reaction (Crossley and Hills, *Journ. Chem. Soc.*, 1906, lxxxix.) resembles closely that of phosphorus pentachloride on dimethyldihydroresorcin (Crossley and Le Sueur, *Journ. Chem. Soc.*, 1902, lxxxi., 826, 1533), for two bodies are obtained: one hydroaromatic, namely, 3 : 5-dichloro-1 : 1 : 2-trimethyldihydrobenzene (8); and the other aromatic, namely, 3 : 5-dichloro-1 : 2 : 6-trimethylbenzene (9).





But whereas, in the case of dimethyldihydroresorcin, about 75 per cent of the theoretical yield of the hydroaromatic dichloride is formed and only a very small proportion of the aromatic substance, with trimethyldihydroresorcin the result is reversed, the principal product being dichlorotrimethylbenzene.

Dichlorotrimethyldihydrobenzene can be converted into dichlorotrimethylbenzene under the influence of phosphorus pentachloride or bromine, and it has been ascertained that during this conversion the wandering methyl group passes into an ortho-position, as has already been observed with several derivatives of dimethyldihydroresorcin (*Journ. Chem. Soc.*, 1902, lxxxi., 1534; 1904, lxxxv., 264). This has been proved by analogy, and by a study of the properties of the aromatic dichloride and of the possibility of directly esterifying the dichlorobenzenetricarboxylic acid (dichlorohemimellitic acid) obtained by oxidising dichlorotrimethylbenzene with nitric acid in sealed tubes.

(To be continued).

## THE PASSAGE OF ELECTRICITY THROUGH LIQUIDS.*

By W. C. DAMPIER WHETHAM, M.A., F.R.S.,
Fellow of Trinity College, Cambridge.

OUR subject of this evening owes much of its early development to researches carried on in the Royal Institution. Here Davy investigated the chemical effects of electric currents, and, in 1807, discovered the elements potassium and sodium by the decomposition of the alkalis by the electric current. Here Faraday discovered the quantitative relation between the strength of the electric current on the one hand and the amount of chemical action on the other, and thus raised the subject to the rank of an exact science.

Let us pass an electric current through a solution of some salt, and observe the resultant changes. To make these changes visible, let us choose a coloured salt, such as copper sulphate. As soon as the circuit is completed, we see that one of the copper terminals or electrodes, by which connection is made with the solution, begins to dissolve away, while copper is deposited on the other electrode. Thus copper passes through the solution, disappearing at one end and appearing at the other. The direction in which the copper passes is that which is taken conventionally as the direction of the electric current.

It will be seen that the middle part of the solution is unaffected. The chemical changes occur at the electrodes only; at one copper is deposited, at the other copper is dissolved as sulphate, showing the presence of acid in contact with the metal. The chief facts to be explained, then, are the appearance of the opposite constituents of the salt—copper and acid—at the electrodes, and the total absence of change in the body of the solution.

We may explain these phenomena by the supposition that oppositely moving streams of the two parts of the salt proceed through the liquid. In the middle there will always be equal quantities of the opposite parts, and the concentration of the solution is unaltered, but at the ends the parts are set free. The conception may be illustrated by a model, in which differently coloured balls, fixed to movable strings, represent the opposite parts of the salt.

These moving parts of the salt must be electrified, since they move when acted on by an electric force. They were called by Faraday the ions. To a further study of the nature and properties of these ions I ask your attention to-night.

Faraday found that, on passing a steady electric current through a decomposable liquid or electrolyte, the amount of chemical decomposition was proportional to the strength of the electric current, and to the time of current-flow—that is, to the total quantity of electricity which passes. Hence a given quantity of any ion, such as copper or chlorine, must carry with it a definite charge of electricity. Moreover, the mass of substance deposited by a given

* A Discourse delivered at the Royal Institution, February 16, 1906.

current in a given time was found to be proportional to its chemical equivalent weight. Thus equal numbers of equivalents, whether of the same or of different ions, must be associated with equal charges.

If we accept the atomic theory, we must regard the chemical equivalent weight of a substance as proportional to the mass of its atom divided by its valency, *i.e.*, by the number of univalent atoms—such as that of hydrogen—which one atom of the substance will combine with or displace. Faraday's experiments then mean that each univalent ion carries the same charge of electricity, each divalent ion twice that charge, and so on. The charge on one univalent ion is a true natural unit of electricity, which is thus seen to be quite as atomic in its nature as is matter.

We must now regard the process of electrolysis (*i.e.*, the passage of electricity through a decomposable liquid or electrolyte) as a kind of convection, the electric current being carried through the liquid somewhat as water may be carried from point to point in a number of buckets.

If a current be passed for some time through a solution, such as that of copper sulphate, not only is copper dissolved from the anode, or plate by which the current is said conventionally to enter the solution, and deposited at the cathode or place of exit, but a notable change in concentration is noted in the solution near the two electrodes. The liquid near the anode becomes more concentrated, and that near the cathode more dilute. This may easily be illustrated by an experiment. If instead of copper we use platinum as anode, it is not dissolved, and the total amount of copper in solution progressively diminishes. We then find that, while salt is taken from the neighbourhood of both electrodes, more comes from the cathode than from the anode. These phenomena were studied extensively by Hittorf about the years 1850—1860.

Two explanations of this uneven dilution of the solution are possible. We may suppose that the ions are complex structures, and drag unaltered salt or solvent with them through the liquid, or we may suppose that they move with unequal velocities. It is now probable that in some cases both these factors come into play, but, to simplify our ideas, let us first imagine that the opposite ions are simple, or at all events loaded with equal amounts of salt or solvent, and that they move with unequal speeds through the liquid. The use of the model to which we have already referred enables us to see clearly that the velocity of the anion is to that of the cation as the amount of salt lost by the solution near the cathode is to that near the anode. The ratio of the opposite velocities of simple ions could then be deduced from experiment.

In the year 1879, it was pointed out by F. Kohlrausch that the sum of the opposite ionic velocities might be calculated from a knowledge of the electrical conductivity of the liquid. The conductivity, that is the amount of current conveyed under the influence of a given electromotive force, is obviously proportional to the number of ions, to the velocity with which they move, and to the electric charge carried by each. On the assumption that all the salt is actively concerned in conveying the current, we know the number of grm.-equivalents of either ion present from a knowledge of the concentration of the solution. Now Faraday, as we have said, discovered that the amount of substance deposited at the electrodes by a given quantity of electricity was proportional to the chemical equivalent of the substance. This means that a given number of ions, whatever their nature, so long as their chemical valency be the same, carry the same amount of electric charge. The charge on a univalent ion is thus seen to be a true natural unit of electricity; the charge on a divalent ion consists of two such units; that on a trivalent ion, of three. Faraday's quantitative measurements tell us the charge on a grm.-equivalent of any univalent ion. The concentration of our solution tells us the number of grm.-equivalents present; thus, by measuring the conductivity, we can calculate the velocity with which the ions move under a given electric force. By this method, Kohlrausch calculated the specific velocity of many simple ions when moving through dilute aqueous solutions.

In 1886, Sir Oliver Lodge rendered visible the movement of ions which hitherto had been seen by the eye of faith only. By forcing hydrogen ions from a vessel of acid through a tube containing a jelly solution of sodium chloride, he rendered their presence visible by an indicator which changed colour in the presence of an acid, and thus watched their progress through the tube.

In order to compare the ionic velocities as directly observed with those calculated by Kohlrausch, further modifications of the method are necessary. One arrangement which may be used is to employ two solutions which have a common ion, different densities, a nearly equal specific resistance, and different colours. One of these solutions is placed on the top of the other and a current passed across the junction, the movement of which gives us the velocity of the coloured ions. This method is restricted in scope, but the use of jelly solutions, in which the velocities are not markedly different from those through solutions in water, enables us to use traces of precipitates or indicators to show the movement of various ions. Such experiments showed that the observed velocities were in general agreement with those calculated by Kohlrausch.

If the specific resistances of the two solutions be not equal, interesting phenomena occur at the boundary. The electric force will be greater in the solution where the resistance to be overcome is greater. Hence if an ion from the other solution chance to pass the boundary, it finds itself subjected to a greater force, and its velocity is increased. It will thus be pushed further in advance of the junction if it has got in front, and will be brought up into line again if it has straggled behind. We see, then, that if a junction be advancing in the direction of the solution of higher resistance, the junction will become vague and indistinct, while if the advance be towards the solution of lower resistance the junction will keep sharp and well defined. When the solutions have one ion in common, this means that in order to secure a sharp boundary, we must arrange that a specifically slower ion shall follow a faster one.

Professor Orme Masson recognised that these principles enabled us to dispense with the necessity of choosing two solutions of equal resistance. A salt with quickly-moving ions, such as potassium chloride, is placed in a jelly solution in a horizontal tube. A slow coloured cation is forced electrically into the tube from one end and a slow coloured anion from the other. Thus blue copper may follow the potassium, and the yellow chromic acid ion $CrO_4$ may follow the chlorine. The higher specific resistance in the two coloured solutions forces their ions to conform to the movement of the potassium and chlorine, and thus the motion of the boundaries gives us the velocities of the potassium and chlorine in a solution of constant and known concentration, and therefore their velocities under a known electric force.

Further improvements were made by Mr. B. D. Steele and Mr. F. B. Denison. The use of jelly in the tube was dispensed with by placing membranes over the ends of the tube, and removing them when once the junctions had got well within it. The use of coloured solutions also was found to be unnecessary, for, with sharp junctions, the line of demarcation was visible, owing to the slight difference in the refractive indices of the solutions, and may be shown by projection on a lantern-screen. Denison and Steele have made a careful series of experiments by this method, and in their hands it is probable that the results thus obtained are more accurate than those given by the methods of Hittorf and Kohlrausch.

The general result of these direct measurements of ionic velocity goes to confirm the indirect calculations of the methods of Hittorf and Kohlrausch, in the case, at all events, of simple univalent ions.

Now Kohlrausch finds that the velocity of any one such ion through a dilute aqueous solution is independent of the nature of the other ion present. Thus, for instance, the velocity of chlorine is the same in dilute solutions of

potassium chloride as in solutions of sodium chloride. The velocity under a given electric force is a characteristic property of each ion when moving through a dilute aqueous solution. This result suggests that the ions are independently mobile—that they migrate through the liquid independently of each other.

On this view we must suppose that a large proportion of the whole number of molecules of salt present in a solution is composed of dissociated ions—ions, that is, which are not combined with each other, though they may be linked with solvent molecules. The alternative to this supposition seems to be that the motion of the ions is secured by their passage from molecule to molecule at the instants of inter-molecular collision. On this view, the speed with which the ions worked their way through the solution would depend on the frequency with which collisions occurred. The frequency of collision will depend on the square of the concentration; if the number of molecules be doubled, the number of collisions per second will be four times as great. Hence the velocity of the ions should be greater in concentrated solutions, and the conductivity, which depends on the product of the ionic velocity, and the number of ions, should be proportional to the cube of the concentration. But experiment shows that the velocity of the ions is nearly constant with changing concentration in dilute solutions, and slowly diminishes with increasing strength as the solutions become stronger. We are thus driven back to the idea that the ions migrate independently of each other through the liquid. Much non-electrical evidence pointing to the same conclusion has come to light, and has lent support to the theory of electrolytic dissociation.

I do not propose to enter in this place into a discussion of that theory. But I wish to point out that the evidence, electrical and other, in its favour points merely to a dissociation of the opposite ions from each other; it does not involve the idea of charged particles of, say, potassium or chlorine free from all combination. It may well be that the charged atoms, dissociated from each other, are linked, permanently or temporarily, with one or many molecules of the solvent.

Several facts seem indeed to show that some such combination does occur. If the temperature of a solution be varied it is found that the velocity of the ions alters in about the same ratio as the viscosity of the liquid. Now the viscosity gives the friction which the liquid exerts upon a body moving through it—the dimensions of the body being very large compared with the dimensions of the molecular structure of the liquid. There seems no reason to suppose that the resistance suffered by a single atom, struggling through a crowd of other atoms or molecules, would be related intimately to the ordinary viscosity. In fact, where the structural dimensions of the medium which determine its viscosity are large compared with those of the moving body, it is known that no such relation holds. Thus there is no proportionality between the variation in viscosity of a salt solution when successive quantities of gelatine are added and the variation in the velocity of the ions of the salt. Here the gelatinous structure is probably a sort of fibrous network, very coarse compared with molecular dimensions.

Thus, the approximate proportionality between variation of viscosity with temperature and variation of ionic velocity, indicates that the dimensions of the ions are probably as large as, or larger than, the dimensions of the molecular structure of the solvent. We may perhaps regard the ions as composed of a central charged nucleus, surrounded by a group of solvent molecules. Such a view is supported by Kohlrausch and by Bousfield.

It should be noticed, however, that the solvent molecules cannot remain attached to the charged nucleus throughout its whole journey. The different ionic velocities of potassium, sodium, and lithium, for instance, indicate differences in the amount of the watery ionic envelope. The amount of water transported through a dilute solution of a chloride by these three ions cannot be the same; it cannot, in each case, be equal to that transported by the chlorine ion. If the water were permanently attached to the nucleus till it reached the electrode, we should get changes in concentration not contemplated by the theory of Hittorf and Kohlrausch, and the migration constants directly determined by Steele and Denison would not agree with those measured by Hittorf. We must suppose, therefore, that the moving ionic system continually sheds some of its watery envelope, and continually replaces it by fresh water molecules.

One of the most interesting properties of these charged ionic systems is their power of causing the coagulation of certain solutions of colloids, such as albumen. If an electrolyte be added to such a solution in sufficient quantity, coagulation at once ensues, and a curious relation between the coagulative power and the chemical valency of the ionic nucleus enables us to obtain some light on the mechanism of the process. Hardy has shown that colloids themselves generally move through a solution when an electric field is applied, the direction of motion depending on the nature and condition of the liquid solvent. It follows that the colloid particles themselves possess an electric charge, and Hardy finds that the effective ion of the coagulating electrolyte is the ion with an electric charge of sign opposite to that on the colloid. It seems that coagulation is effected by the neutralisation of the charge on the colloid. Now a very much smaller quantity of a divalent salt is able to produce coagulation than is necessary in the case of a univalent salt, and the coagulative power of a trivalent salt is greater than that of a divalent salt. As mean values, Linder and Picton give for the coagulative powers of sulphates of univalent, divalent, and trivalent metals the relative numbers 1 : 35 : 1023.

As we saw above, Faraday's experiments show that a univalent ion is associated with one natural unit of electricity, a divalent ion with two such units, and a trivalent ion with three.

Let us suppose that to effect the coagulation of a region of colloid solution, it is necessary for a certain electric charge, equal in amount to that on the colloid particles present and opposite in sign, to be brought within the region. This can only be done by the chance conjunction of ions which, in the absence of an external electric field, must be supposed to be moving in irregular and changeable ways throughout the liquid. If the chance of one ion entering the region be represented by $1/x$, that of two ions entering together will be the product of these separate chances or $1/x^2$, while the chance of the triple event of these conjunctions will be $1/x^3$.

Now, to obtain an equal amount of electricity, we need the presence of 2 trivalent ions, 3 divalent ions, or 6 univalent ions; and, if we work out the problem for solutions containing the same number of molecules, we find that the relative coagulative powers of univalent, divalent, and trivalent solutions should stand to each other in the general approximate ratio of—

$$1 : p : p^2.$$

The value of the $p$ depends on unknown quantities, such as the effective radius of ionic action, and cannot at present be calculated theoretically. But, by putting $p$ equal to 32, it is easy to see that the law of increase of coagulative power with valency is that we have deduced; for the theoretical numbers—

$$1 : 32 : 1024$$

agree well with Linder and Picton's mean results.

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**Electric Conductivity of Hydrochloroferric Colloid.**—G. Malfitano.—Solutions of hydrochloroferric colloid, when sufficiently dilute, have an electric conductivity whose value is very nearly that of the liquid which remains after filtering through collodion.—*Comptes Rendus*, cxliii., No. 3.

## ITALIAN SOCIETY OF SCIENCES KNOWN AS THE SOCIETY OF THE XL.*

Report *on the Award of the Matteucci Medal (year* 1906), *presented by the Commission composed of the Members* Blaserna, Righi, *and* Roiti.

James Dewar, born in 1842 at Kincardine-on-Forth in Scotland, completed his studies and took the first steps in his professorial career in the University of Edinburgh; in 1873 he was appointed Professor of Natural Philosophy at Cambridge, from which post he was promoted Fullerian Professor in the Royal Institution in London, where he is likewise Director of the Laboratory founded in memory of Davy and Faraday.

We shall not pause to enumerate all the contributions which he rendered to the knowledge of aromatic compounds, nor the other important investigations in chemistry by which he initiated his scientific career. But we cannot omit to point out the work which he carried out from 1878 to 1890, for the most part in conjunction with Professor G. D. Liveing, of Cambridge, which work undoubtedly forms part of the finest that has yet been produced in the field of spectrometry. This work is set out in about fifty short notices free from all preconceived ideas and admirable in their experimental genius, enriched with data meriting the highest attention and universally accepted, and fertile in their theoretic bearing and scope. Dewar and Liveing were the first to investigate the phenomena of inversion in many elements; afterwards they studied the influence of temperature on the spectra of the same elements, and the way in which these spectra were modified by the presence of other elements. Extremely interesting are their researches regarding the various spectra of carbon and its compounds, and in relation to the phenomena of synthesis manifested in the electric arc. They, moreover, furnished the first exact determinations of the ultra-violet spectral region, assigning with the utmost care the wave-lengths for a fair number of elements.

Various other problems made evident Dewar's extraordinary experimental ability, and his world-wide fame was secured by the problem, more than any other, of obtaining extremely low temperatures, to which he has indefatigably and courageously devoted himself for more than twenty years, with the satisfaction of seeing his labours crowned by the liquefaction and solidification of hydrogen, which allowed him to study the chemical and physical properties of gases formerly held to be irreducible, when they have changed their state of aggregation.

Having ingeniously contrived means for rendering inconsiderable the losses by evaporation of these new and highly volatile liquids, and thus for preserving them for a length of time in large quantities, he turned this to able account in order to investigate the very varied phenomena which took place at their boiling temperatures, low in themselves, and still further lowered by expansion.

Most extensive is the field covered by Dewar in his studies of this kind; variations of density and cohesion, chemical and photographic actions, phosphorescence and radio-activity, optical properties, thermo-electricity, electric conductivity and inductivity, and magnetic susceptibility. It would take too long to enumerate here the important and partly unexpected results obtained by him, and indeed it is superfluous, as they are present in the minds of all. Let us rather restrict ourselves to accompanying the Matteucci Medal, which we award him, by the wish that, from the 13° which he has already reached, he may descend still further downwards towards absolute zero, and succeed in liquefying even helium.

The Commission:—

P. Blaserna.
A. Righi.
A. Roiti.

Rome, July, 1906.

* Extract from Series 3A, Vol. XIV.

## ON THE DISTRIBUTION OF RADIUM IN THE EARTH'S CRUST.*

By the Hon. R. J. STRUTT, F.R.S., Fellow of Trinity College, Cambridge.

### Part II.—Sedimentary Rocks.

In a paper read before the Society on April 5, I gave determinations of the quantity of radium in igneous rocks (see Chemical News, vol. lxxxiii., p. 235). Similar data for sedimentary deposits will now be given to complete my survey of the radium content of the earth's crust.

The limestones examined (oolite, chalk, marble, &c.) were simply dissolved in hydrochloric acid, and the emanation extracted from the solution. All other rocks (including sandstones, clays, slates, gravel) were first fused with sodium carbonate, in exactly the same way as the igneous rocks dealt with in the former paper. I believe that in some cases, clays for instance, this is unnecessary; for determinations made on clay simply treated with hydrochloric acid gave the full quantity of emanation.† But to avoid any doubt, fusion was always resorted to.

The results for sedimentary rocks are given in Table I.

Table I.

| Rock. | Locality. | Radium per grm., in grms. |
|---|---|---|
| Oolite | Bath | $5{\cdot}84 \times 10^{-12}$ |
| Oolite | St. Alban's Head | 4·05 „ |
| Marble | East Lothian | 3·87 „ |
| Kimmeridge clay | Ely | 3·77 „ |
| Oil-bearing sandstone | Galicia | 3·04 „ |
| Roofing slate | Wales (?) | 2·57 „ |
| Silicified gritty slate | St. Ives, Cornwall | 2·50 „ |
| Gault clay | Cambridge | 2·13 „ |
| Clay | Terling, Essex | 1·73 „ |
| Red sandstone | East Lothian | 1·68 „ |
| Gravel (fine siftings) | Terling, Essex | 1·42 „ |
| Red chalk | Hunstanton | 1·07 „ |
| Flint (large nodules) | Terling, Essex | 1·06 „ |
| White marble | Deccan, India | 0·54 „ |
| Marble | East Lothian | 0·52 „ |
| Chalk | Bottom of pit, Cherry Hinton, Cambs. | 0·78 „ |
| Chalk (*a*) | Top of same pit | 0·25 „ |

(*a*) This determination was made on 500 grms. of material, in order to get a sufficient leak for measurement.

On comparing these figures with those given in my former paper for igneous rocks (*Proc. Roy. Soc.*, A, vol. lxxvii., p. 479, last column but one of the table), it will be observed that the average radium content of sedimentary deposits does not differ appreciably from that of igneous rocks. This is what might be expected on the received view that sedimentary rocks derive their material from the disintegration of igneous ones.

It appears then that the examination of sedimentary rocks for radium gives no reason for altering the estimate of the radium content of the earth's crust formerly arrived at.

I have examined a few other materials which cannot be properly destribed as rocks, but which are of interest in the present connection.

The results are given below:—

Table II.

| Material. | Radium per grm., in grms. |
|---|---|
| Deposit from hot springs, Bath | $828 \times 10^{-12}$ |
| Cambridge tap-water (*a*) | 0·78 „ |
| Sea-salt (approximate determination only) | 0·15 „ |
| Boiler crust, Cambridge | 0·078 „ |

(*a*) This is the quantity of radium which corresponds to the emanation dissolved in 1 c.c. of the water. The radium is not itself present in the water.

* A Paper read before the Royal Society, June 21, 1906.

† The emanation cannot be quantitatively extracted from clay by merely boiling it with water.

It will be noticed that the deposit from the Bath spring is 100 times as rich as any rock. The materials transported by cold water, sea-salt, and boiler crust are, on the other hand, much poorer in radium than any of the rocks.

### Part III.—Rock-forming Minerals.

Igneous rocks are aggregates of many distinct minerals. It was felt that the enquiry as to the distribution of radium in such rocks would be incomplete without some attempt to determine in which of these minerals that element chiefly resides.

Most of the rock-forming minerals can be obtained in large well developed crystals. Such crystals occur for the most part in exceptional localities where crystallisation has been extremely slow, and where the structure of the rocks is on a large scale throughout. In these cases it is easy to obtain any desired quantity of the pure mineral for investigation.

I have examined a number of such specimens of rock-forming minerals for radium. The results are given in Table III. In some cases the quantity of material taken for the experiment proved insufficient to give a satisfactory quantitative measure of the amount of radium in the mineral. This is indicated by a note of interrogation. In other cases no radium at all was detected. In all probability some traces would have been found if more of the mineral had been taken, but the object was to determine whether the mineral made any important contribution to the total radium in the rock. Thus it was not thought worth while to push the examination of accessory minerals, such as ilmenite or rutile, which only occur in small proportions, very far. The quantities of material taken for these experiments are given, so that the quantitative significance of a negative result may be judged.

Table III.

| Mineral. | Locality where found. | Quantity taken. Grms. | Radium per grm. Grms. |
|---|---|---|---|
| Zircon | Ural Mountains | 1 | $865 \times 10^{-12}$ |
| Zircon | North Carolina | 1 | 658 ,, |
| Zircon | Brevig | 0·690 | 139 ,, |
| Zircon | Kimberley | 1·17 | 74·8 ,, |
| Perofskite | Magnet Cove, Arkansas | 1 | 197 ,, |
| Sphene | ? | 1 | 102 ,, |
| Apatite | Sweden | 8 | 29·7 ,, |
| Apatite | California | 4·7 | 11·0 ,, |
| Hornblende | ? | 7·5 | 4·27 ,, |
| Tourmaline | Devonshire | 11·3 | 3·32 ,, |
| Labradorite | Labrador | 17 | 1·1 ,, ? |
| White felspar | Nellore, India | 20 | 0·6 ,, ? |
| White mica | Nellore, India | 10 | 1·0 ,, ? |
| Brown mica | Deccan | 10 | 1·0 ,, ? |
| Brown mica | ? | 10 | Nil |
| White quartz | Nellore, India | 30 | Nil |
| Rutile | ? | 1 | Nil |
| Ilmenite | ? | 1 | Nil |

It will be observed that certain of the accessory minerals, *i.e.*, zircon, sphene, perofskite, and apatite, which occur in granite, are rich in radium. The hornblende, micas, tourmaline, and felspars examined contain much less, while in quartz none could be detected.

Although these experiments throw a certain amount of light on the subject, they are in some respects inconclusive. It is not safe to take these exceptional cases where large crystals occur, as typical; for slow crystallisation is likely to result in more perfect separation of the constituent elements. Moreover, it is difficult to form any idea of the proportion in which the various minerals occur, especially when there has been no opportunity of examining them *in situ*. One cannot tell, for instance, whether enough zircon occurs to account for any large fraction of the radium contained in the whole rock. I have accordingly made some experiments by separating the constituents of an ordinary rock. For this purpose Cornish granite was selected, as being comparatively rich in radium, and coarse enough to allow of easy separation of the constituent minerals. Sixty-five grms. of Cornish granite was powdered just so far that each particle was seen to be composed of one mineral only, when examined with a magnifier. Bromoform was used to separate the dense minerals from the light ones. The dense minerals, which sank, weighed only 7·5 grms. The rest of the powder, consisting of quartz and felspar, floated on the liquid.

The dense portion consisted mainly of brown mica, but may have contained some zircon enclosed between the flakes, the separation of which by mechanical methods would be impracticable. The dense portion was accordingly digested with hydrochloric acid until the flakes had lost all their colour, nothing but silica remaining. This treatment would leave the zircon behind, as it is not appreciably acted on by hydrochloric acid.

The rock was thus divided into three portions. The quantity of radium in each of these portions was determined by the usual method.

The result was that 1 grm. of Cornish granite contains :—

| | Radium (grms.). |
|---|---|
| In the light portion (quartz and felspar) | $3·85 \times 10^{-12}$ |
| In the heavy portion, soluble in HCl (brown mica) | 4·27 ,, |
| In the heavy portion, insoluble in HCl (zircon ?) | 1·02 ,, |
| Total | $9·14 \times 10^{-12}$ |

It appears, therefore, that more than half of the radium is contained in the heavy minerals, though these are only one-eighth of the whole mass of the rock. Although the separation by means of bromoform was not perfect, it was, I think, good enough to make it certain that a considerable portion of radium is really contained in the light constituents. As to the heavy minerals, it would not seem that there is enough zircon to account for much of the radium, which chiefly resides in the brown mica.

It appears that radium, or rather its parent, uranium, is not perfectly separated from a rock magma by the crystallisation of the heavy constituents, though considerable concentration in these constituents occurs.

## CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxliii., No. 3, July 16, 1906.

**Absorption of Nitrogen by Organic Substances under the Influence of Radio-active Materials.**—M. Berthelot.—The author's experiments prove that radio-active materials, to a certain degree, play the same part as an electric current in determining the fixation of nitrogen and oxygen on to organic substances.

**Reduction of Molybdenum Dioxide by Boron. Compounds of Boron and Molybdenum.**—Binet du Jassonneix.—The reduction of molybdenum oxide by boron, and the union of the two elements, can be obtained under the influence of the electric furnace in crucibles of pure magnesia. Non-carburetted melts are thus obtained, containing proportions of boron up to 46 per cent.. These compounds are attacked by dilute nitric acid.

No. 4, July 23.

**Zirconium Silicide, $ZrSi_2$, and Titanium Silicide, $TiSi_2$.**—Otto Hönigschmid.—The reduction of zirconium oxide and the double fluorides of potassium and zirconium by the alumino-thermic method, and in presence of a large excess of silicon, gives the silicides $TiSi_2$ and $ZrSi_2$.

The latter is in the form of small iron-grey crystals, with a very decided metallic lustre. The mineral acids have no action on this silicide, with the exception of hydrofluoric acid, which dissolves it easily, with evolution of hydrogen. Titanium silicide is also in the form of iron-grey crystals. This substance oxidises only with great difficulty, but it burns in chlorine below red heat. It also is soluble only in hydrofluoric acid.

**Alloys of Lead and Calcium.**—L. Hackspill.—The author prepares alloys of lead and calcium by the electrolysis of a mixture of chloride and fluoride of calcium, using a cathode of molten lead. The alloys thus prepared are harder and less malleable than lead, and tarnish rapidly in air. When heated in air the calcium oxidises first, giving lime and calcium nitride, which in part protects the lead from oxidation. Water attacks the alloys slowly in the cold, more rapidly when boiling. The author also tries to increase the proportion of calcium in the alloy to 21 per cent by heating it in a vacuum, so as to distil off the excess of lead. At the end of one and a-half hours he obtains an alloy containing 11·8 per cent of calcium; the formula $Pb_3Ca_2$ requiring the composition Pb = 88·49 per cent, Ca = 11·51 per cent. The melting-point of this is 775°, and its density 7·6, and the substance is definitely crystalline.

**Spectra of Cathodic Phosphorescence of Terbium and Dysprosium Diluted with Lime.**—G. Urbain.—Inserted in full.

**Radio-active Lead Extracted from Pitchblende.**—Jean Danysz.—The author measures the radio-activity of the lead extracted from pitchblende by means of the piezo-electric quartz. To measure the penetrating radiation, he absorbs all the easily absorbable radiation by a sheet of aluminium 0·025 m.m. thick placed some millimetres above the salt. He also verifies the fact that this completely stops the radiation emitted by a sheet of poloniferous silver which is strongly radio-active.

**Constitution of Hordenine.**—E. Léger.—The production of picric acid during the action of $HNO_3$ on hordenine shows, not only that this base contains a benzenic radicle, but that its oxyhydryle is directly attached to this radicle. In other words, that this oxyhydryl is of a phenolic nature, which can be expressed by saying that hordenine contains the group $C_6H_4{<}_{OH}$. A series of experiments, which the author has not yet completed, lead him to suppose that the radicle containing the nitrogen group is due to the intermediary of a chain, $—CH_2—CH_2—$. By this hypothesis the formula of hordenine would be $C_6H_4{<}^{CH_2—CH_2—N{<}^{CH_3}_{CH_3}}_{OH}$, corresponding to the expression $C_{10}H_{15}NO$. The author proposes to verify the exactness of this formula, which he here gives with certain reservations.

**Action of Phenyl-magnesium Bromide on the Ethers of the Dialcoylamido-benzoyl-benzoic Acids.**—J. Pérard.—The author investigates the action of phenyl-magnesium bromide on the ethers of the dialcoylamido-benzoyl-benzoic acids. He thus prepares para-dimethylamido-triphenyl-oxy-dihydro-benzofurfurane,

$$\begin{matrix} C_6H_5 \\ C_6H_4 \\ C_6H_5 \end{matrix}{>}C{<}^{C_6H_4N(CH_3)_2}_{O}{<}_{OH}$$

, and a certain number of its derivatives, such as the methylic ether, ethylic ether, &c.

**Introduction of Dinaphthopyryl and Xanthyl Radicles into Electro-negative Molecules.**—R. Fosse and A. Robyn.—The electro-positive radicles, dinaphthopyryl, $CH{<}^{C_{10}H_6}_{C_{10}H_6}{>}O$, and xanthyl, $CH{<}^{C_6H_4}_{C_6H_4}{>}O$, can easily be substituted for one atom of hydrogen in various organic electro-negative molecules—such as the β-ketonic ethers, the β-diketones, the malonic and cyanacetic ethers. The positive radicle unites with the negative radicle—(1) By the simple action of heat on an equimolecular mixture of xanthydrol and β-ketonic or cyanacetic ether; by virtue of its extreme mobility, the hydroxyl of the xanthydrol unites with one atom of hydrogen of the β-ketonic ether to form one molecule of water, whilst the xanthyl unites with the negative radicle. (2) By contact in acetic medium. (3) By double decomposition between the bromide of dinaphthopyryl and the sodium derivative of the β-ketonic ether, the β-diketones, the malonic and cyanacetic ethers.

ERRATA.—Vol. xciii., p. 213, col. 2, line 35 from bottom, *for* "3 c.c. hydroxylamine hydrochlorate" *read* "5 c.c." P. 214, col. 1, line 13, *for* "44·19" *read* "46·19."


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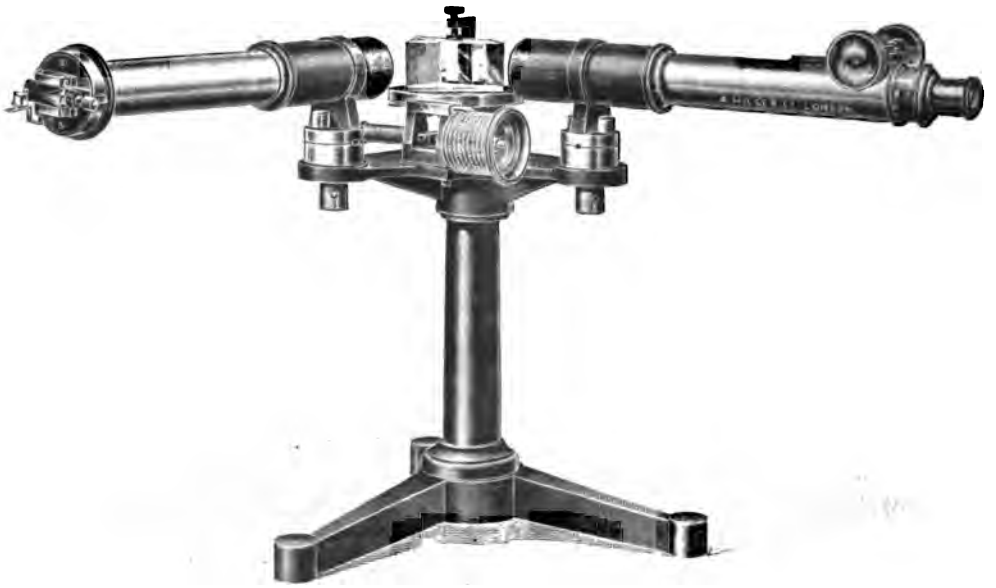

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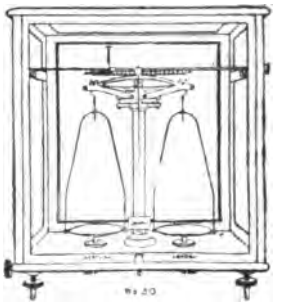

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THE CHEMICAL NEWS.

Vol. XCIV., No. 2440.

## REPORT ON OUR PRESENT KNOWLEDGE OF THE CHEMISTRY OF THE GUMS.*

By H. H. ROBINSON, M.A., F.C.S., F.I.C.

The gums are a class of substances characterised by the property of either dissolving in water to form viscid solutions or of absorbing water to form gelatinous pastes; these solutions or pastes on exposure to air lose their water, and dry to hard translucent somewhat glassy masses. The gums are uncrystallisable, and are composed of carbon, hydrogen, and oxygen. As found in nature they contain more or less ash constituents, and sometimes contain a little nitrogen. The nitrogen, if present, is small in amount, and is not regarded as an essential component, and this differentiates them from gelatin, glues, and proteids, which also possess the above properties, but contain a considerable proportion of nitrogen.

The gums occur in plants, and are often found as exudations on the bark or other surfaces; some gums have also been found in animal products. Different views have been held as to the processes by which gum is formed in the plant. One view considers the production of gum part of the normal metabolism of the plant; in the case of tree-gums they are generally regarded as an excretion resulting from the breaking down of cell tissue. In certain cases it has been attributed to the action of a fungus which attacks the tree, and generates an enzyme that penetrates the tissues and transforms the cell-walls, &c., into gum. A third view attributes it to bacterial action, and it is claimed that specific bacteria have been found capable of producing different kinds of gum. The employment of a system of inoculating the trees to cause the production of gum has been suggested, but the evidence in support of it is as yet very slight.

The word "gum" in its earliest use was probably applied to plant exudations which thickened and hardened on the surface of the plant, and thus it has been applied not only to substances which have an affinity for water but also to resins and caoutchouc. As the latter are very different in their composition and properties from the substances of the class described above, it is most convenient not to include them with these.

One of the earliest recorded uses of the word is by Herodotus, who described (about 450 B.C.) how, in Egypt, the embalmers swathed the corpse in strips of linen smeared with gum, which, he adds, the Egyptians generally use instead of glue; he employs the word κόμμι, from which the word "gum" is descended. The gums have been familiar substances in European literature from that time to the present, being designated by some form or other of the word κόμμι, which itself was not a native Greek word, but was of foreign origin.

The views held regarding the chemistry of the gums since the year 1774, which may be regarded as the period of the dawn of modern science, have passed through three phases.

In the first phase they were regarded as being among the proximate or immediate principles of plants; such a proximate principle being defined as a distinct compound existing ready formed in plants. They were accordingly placed in the lists of such principles, which at that time were not very extensive. It was then imagined that the chemistry of animal and vegetable products was far simpler than we now know it to be. It was known that the gums were composed of carbon, hydrogen, and oxygen, with possibly some nitrogen.

In the second phase, as analysis appeared to show that the hydrogen and oxygen were in the same proportions as in water, they were considered to be carbohydrates; and when by studying the action of reagents on them it was found that on hydrolysis they yielded various sugars, they were classed as polysaccharides; that is, substances formed of two or more sugar residues united together and differing from the sugars by one or more molecules of water.

In the third phase, by a more careful and systematic series of fractionations and hydrolyses, several of the gum substances have been shown to be built up of the residues of sugar molecules united by an ethereal oxygen attachment to an organic acid, which is different in different gums, and which may be regarded as the nucleus of the particular gum. In other words, they are glycosides of certain organic acids. The number of these sugar residues in a gum compound is considerable, and the natural gum is often a mixture of several gum compounds differing from one another in the number of sugar residues in their molecules. As the attachment is ethereal and not like that of an ester, the gum compounds possess acid properties, since the acid groups are not neutralised by the sugar residues.

This is the most modern view, and doubtless many, if not all, of the gums will be found to be of this nature when fresh examination of them has been made.

It must be understood, however, that these phases are not sharply marked off from one another in sequence of time, the germs of the later idea being often found in the records of earlier investigations.

In the early part of the Nineteenth Century a good many gums were known, the most familiar of which were gum-arabic, gum tragacanth, gum Bassora, gums from the genus *Prunus*, such as cherry-tree gum, and the mucilages or gum solutions obtained from linseed and from quince seed.

At that period the activity awakened by the new ideas in chemistry was the cause of various attempts to ascertain the nature of the substances that form the different gums. The work then done resulted in the descriptions of the properties of a few gum substances believed to be individual chemical compounds, to which the names *bassorin*, *cerasin*, and *arabin* were given. After these names had been assigned chemists, dominated by the idea that the number of organic compounds was only small, on investigating a gum identified its constituents with one or more of these substances. As these identifications rest on only a few simple properties but little weight attaches to them. In fact, it now appears that the number of gum compounds is very considerable; consequently in reading the literature of the last century statements that the author had found the presence of arabin, or cerasin, or bassorin, &c., do not throw any certain light on the nature of the substance found, as it cannot be safely inferred that it is the same substance as the arabin, or cerasin, or bassorin, &c., found in another natural product by another author.

It may be of some interest to trace the origin of these names so often attached in the last century to the components of the different gums.

*Bassorin.*—In 1811, Vauquelin published an examination of gum Bassora, and in the same year Pelletier, who was engaged in examining several gum resins, published a paper in which he proposed the name *bassorine* for the substance constituting the gum Bassora described by Vauquelin, since he believed he had found the same substance in the gum resins. Gum Bassora appears to be a gum having properties somewhat similar to those of tragacanth, but not to be so highly valued. It derives its name from the Turkish port now called Basra, at the head of the Persian Gulf, from which there is a considerable export of gums. A gum Bussora is still quoted in the London market reports, but whether it is the same gum as that examined by Vauquelin, or whether it really comes

* A Paper read before the British Association (Section B), York Meeting, 1906.

from Basra, is not easy to say, since trade terms of the kind are often misleading.

*Cerasin.*—In 1812, John, who was aware of Vauquelin's work, published an examination of several gums derived from the genus *Prunus*, and gave the name of *cerasin* or *prunin* to the gum substance he obtained from the fruit of the plum known as Mirabel, and also from the stem of the wild cherry-tree, *Prunus avium*. He found that the gum of the sweet cherry-tree was of a different nature. The term "prunin" did not come into use, but "cerasin" has often been used.

*Arabin and Para Arabin.*—In 1833, Chevreul, in reporting on a memoir on the gums written by Guérin, gave the name *arabine* to the gum substance of gum-arabic and of gum Senegal, and remarked that if cerasin should prove to be identical in composition with arabin it ought to be called *para arabine*.

Roughly speaking, it may be said that in the descriptions of the gums the part soluble in cold water was put down as arabin and the part insoluble in cold water was put down as cerasin or bassorin.

*Metagummic Acid and Gummic Acid.*—In 1860, Frémy published a paper in which he described a substance obtained by pouring a strong solution of gum-arabic on to concentrated sulphuric acid. This substance is insoluble even in boiling water, but alkalis cause it to dissolve, and then acids do not re-precipitate it from the solution. He gave the name *metagummic acid* to the insoluble acid and *gummic acid* to the soluble acid produced by the action of alkalis on metagummic acid and also existing in soluble gum. He remarks that these experiments modified all the ideas then held concerning gum-arabic, which up to then had been considered as a neutral substance comparable to dextrin, but that it now appeared that the natural gum was a lime salt of an acid. It was, in fact, gummate of lime, and the insoluble natural gum ceresine was metagummate of lime. It should be mentioned that the term "gummic acid" has also been used for quite a different substance prepared by Reichardt.

*Arabic Acid.*—That gum-arabic was largely composed of an acid had already been discovered by Neubauer and announced in 1854 and 1857, although Frémy was not aware of this. Neubauer made analyses of the acid obtained by freeing gum-arabic of its ash constituents, and also of the salts of this acid, to which he gave the name *Arabinsäure*.

*Metarabic Acid.*—Frémy's term metagummic acid seems to have been changed into *metarabic acid* by later writers, no doubt because his gummic acid was the same as the arabic acid previously described by Neubauer.

As early as 1810, Gay-Lussac and Thénard had analysed gum and had put it in the same class as sugar and starch, stating that these substances were composed of carbon united to hydrogen and oxygen, which were in the same proportions as in water; that is to say, they put it in the class of compounds now called carbohydrates.

An important step in the elucidation of the problem of the constitution of gums was Scheibler's discovery, published in 1868 and in 1873, of a new sugar, *arabinose*, obtainable both from gum-arabic and from a gummy substance yielded by sugar-beet. He also noticed the concurrent liberation of an acid with the sugar, but does not seem to have investigated it further. As early as 1832, however, Guérin had obtained a sugar from gum-arabic by the action of sulphuric acid.

Arabinon, galactose, xylose, fucose, and tragacanthose are other sugars which have been obtained from gums by hydrolysis.

Up till comparatively recently, the gums have been placed among the carbohydrates together with cellulose, starch, and dextrin, and have had the formulæ $(C_6H_{10}O_5)_n$ and $C_{12}H_{22}O_{11}$ assigned to them, and, in fact, this view has not yet been abandoned by the text-books. O'Sullivan, however, has shown that this view of their nature is mistaken, and that the gums are really acids of high molecular weight, and are constituted of an acid grouping forming a nucleus to which are attached a number of the residues of various hexoses, pentoses, and bioses; these residues being linked on to the acid nucleus by an ethereal oxygen attachment, just as the dextrose and lævulose are joined in cane-sugar. In some cases the linking is by two oxygen atoms, and reaction with two molecules of water occurs when the sugar residue is broken off by hydrolysis.

He first dealt with gum-arabic, and in 1884 showed that it contained an acid nucleus of the formula $C_{23}H_{38}O_{22}$, to which in a later paper he gives the name *arabic acid*; it is the λ-*arabinosic acid* of the 1884 paper. The gum substance itself is an acid composed of this nucleus joined to the residues of a number of galactose and arabinose or arabinon molecules; arabinon, $C_{10}H_{18}O_9$, being a biose or disaccharide formed by the union of the residues of two arabinose molecules. On submitting the gum to hydrolytic action of varying degrees of intensity more and more of the sugar residues are split off, and acids of lower and lower molecular weight and of higher and higher neutralising power are obtained until arabic acid is reached. This acid is of considerable stability, and requires strong hydrolytic action to break it up, and it then appears to suffer a great degree of disintegration. In the light of the pentose nature of arabinose announced in 1887 by Kiliani, O'Sullivan assigns to the gum substance the formula $2C_{10}H_{16}O_8,4C_{12}H_{20}O_{10},C_{23}H_{30}O_{18}$, and names it *di-arabinan-tetragalactan-arabic acid*. In this "arabinan" and "galactan" stand for two molecules of arabinose and galactose respectively minus two molecules of water, the termination "-an" indicating the anhydride of the corresponding sugar. The arabic acid nucleus appears in this formula with four molecules of water less than in the free acid, indicating the occurrence of four double oxygen attachments between the sugar residues and the nucleus acid, and showing that sixteen molecules of water are required for complete hydrolysis to arabinose, galactose, and free arabic acid. In the natural gum of course the acid is more or less neutralised by the potash, lime, and magnesia of the ash constituents of the plant. The "arabic acid" of O'Sullivan thus denotes the nucleus acid and not the acid of the natural gum substance; since the latter acid differs in different specimens of gum, this seems to be an advantageous change, especially as it permits of descriptive names being given to the varying natural gum acids.

A gum known in commerce as Geddah gum was next examined by O'Sullivan; it resembles gum-arabic in being soluble in water, but it is dextrorotatory, whilst gum-arabic is lævorotatory. He found that it is a mixture of several gum acids which are constituted of the radicles of galactose and of arabinose or arabinon attached in considerable numbers to a nucleus acid, to which the name *geddic acid* is given. Geddic acid is an isomer of arabic acid, $C_{23}H_{38}O_{22}$. The acids forming the mixture of which the gum itself is composed are of high molecular weight, and differ from one another in the number of arabinon molecules they contain, and consequently in their rotatory power.

The third gum investigated was tragacanth; this, like Geddah gum, was found to be a mixture of several gum acids. It can be separated into a group of acids which remain in solution in dilute alcohol and an insoluble portion for which the old name *bassorin* is appropriated. The acids of the soluble group were found to be built up on a nucleus acid very similar, if not identical with, geddic acid by its union with galactose and arabinose residues. The constitution of the insoluble portion bassorin has not yet been completely worked out, but it yields a nucleus acid of the formula $C_{14}H_{20}O_{13}$, to which the name *bassoric acid* is given, and intermediate acids formed of this acid united to the residues of xylose and of a new pentose sugar named *tragacanthose*.

It has been observed that in the case of the gum from sugar-beet the gum obtained in one season frequently differs in rotatory power from that obtained in another season, and that in the case of gum-arabic different samples

also differ in this respect. The explanation of this was discovered in the work on Geddah gum; the cause lies in the fact that in these varying gums the number of sugar residues attached to the nucleus acid varies, or in some cases it may be that the gums contain mixtures of the same gum acids, but in different proportions.

It was found that in a series of gum acids containing arabinans and galactans in varying numbers joined to geddic acid that there were indications that the rotatory power varied fairly regularly in a series, thus :—

*Series* I.

| | | |
|---|---|---|
| Mon-arabinan-tri-galactan-geddic acid | .. | $[\alpha]_D$ +37° |
| Di- " " | .. | +43° |
| Tri- " " | .. | +49° |
| Tetr- " " | .. | +59° |

*Series* II.

| | | |
|---|---|---|
| Tri-arabinan-tetragalactan-geddic acid | .. | +80° |
| Pent- " " | .. | +90° |
| Hept- " " | .. | +100° |
| Non- " " | .. | +110° |

*Series* III.

| | | |
|---|---|---|
| Tri-galactan-geddic acid | .. .. .. .. | +20° |
| Tetra- " | .. .. .. .. | +22° |
| Penta- " | .. .. .. .. | +30° |

The principal constants in identifying a gum acid are its ultimate composition, its neutralising power for bases, and its rotatory power for polarised light. As such acids do not crystallise fractional precipitation must be resorted to in order to prove their individuality. Determinations of the amount of mucic acid they yield and also of the amount of furfural are helpful. In separating the nucleus acid and in preparing intermediate acids lying between the natural gum acid and the nucleus, hydrolyses of varying intensity must be used followed by precipitation with alcohol and purification by means of dialysis. Sometimes it is more convenient to precipitate as barium salts instead of as the free acids.

There is no doubt that in future work on the gums the methods adopted by O'Sullivan should be followed, and that a determination, not only of the sugars they yield should be made, but also of the nature of the nucleus acid. In fact, a great deal of investigation is required to bring our knowledge of other gums up to the level of O'Sullivan's discoveries in the case of gum-arabic, Geddah gum, and tragacanth.

*References.*


CHEVREUL .. *Nouvelles Annales du Museum D'Histoire Naturelle*, 1833, ii., 126.

FRÉMY .. .. *Comptes Rendus*, 1860, l., 124.

GAY LUSSAC and THÉNARD .. *Annales de Chimie*, 1810, lxxiv., 47.

GUÉRIN .. .. *Annales de Chemie et de Physique*, 1832, xlix. 248.

JOHN . .. .. *Schweigger's Journal für Chemie und Physik*, 1812, vi., 374.

NEUBAUER .. *Journal fur Praktische Chemie*, 1854, lxii., 193; *Liebig's Annalen der Chemie*, 1857, cii., 105.

O'SULLIVAN .. *Journal Chemical Society*, 1884, xlv., 41; 1890, lvii., 59; 1891, lix., 1029; 1901, lxxix., 1164; *Proceedings Chemical Society*, 1889, v., 166; 1891, vii., 131; 1901, xvii., 156.

PELLETIER .. *Bulletin de Pharmacie*, 1811, iii., 556.

REICHARDT .. *Liebig's Annalen der Chemie und Pharmacie*, 1863, cxxvii., 297.

SCHEIBLER .. *Berichte*, 1868, i., 58 and 108; 1873, vi., 614.

VAUQUELIN .. *Bulletin de Pharmacie*, 1811, iii., 49.

*Formation of Gum in the Plant.*—LUTZ, "Étude des Gommes," Thése presentée à l'École Supérieure de Pharmacie de Paris, 1894-95; GREIG SMITH, *Journ. Soc. Chem. Industry*, 1904, xxiii., 105, 972.


THE

# STUDY OF HYDRO-AROMATIC SUBSTANCES.*

(Concluded from p. 91).

## RECENT WORK ON HYDRO-AROMATIC SUBSTANCES.

By Professor A. W. CROSSLEY.

*Hydrocarbons.*—In a paper entitled "Derivatives of Cyclohexene (*Ann. Chim. Phys.*, 1905, [8], vi., 200) Brunel gives a *résumé* of work already published, together with a description of certain new derivatives.

1 : 2-, 1 : 3-, and 1 : 4-dimethyltetrahydrobenzenes have been obtained by the action of zinc chloride on the hydroxydimethylhexahydrobenzenes mentioned below (Sabatier and Mailhe, *Comptes Rendus*, 1905, cxli., 20). They give the corresponding hexahydrobenzenes when treated with hydrogen in presence of reduced nickel.

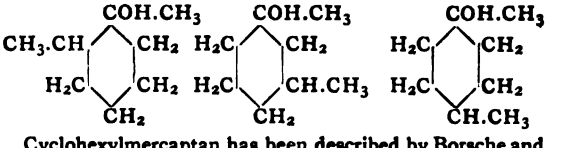
*Alcohols.* — 4-Keto-1-methylhexahydrobenzene reacts energetically with organo-magnesium compounds (Sabatier and Mailhe, *Comptes Rendus*, 1906, cxlii., 438) to form tertiary alcohols of the general formula—

$$CH_3.CH\begin{matrix}<CH_2-CH_2\\ CH_2-CH_2>\end{matrix}C.OH.R.$$

Alcohols in which R = $CH_3$, $C_2H_5$, $C_3H_7$, $C_5H_{11}$, $C_8H_{17}$, $C_6H_5$, and $C_6H_5.CH_2$ are described, and also the substituted tetrahydrobenzenes obtained from them, generally by the dehydrating influence of zinc chloride. An exception was noted in the case of magnesium isobutyl bromide, which gives rise almost exclusively to butylene and hydroxymethylhexahydrobenzene.

4-Hydroxy-1 : 2-dimethylhexahydrobenzene, 4-hydroxy-1 : 3-dimethylhexahydrobenzene, and 2-hydroxy-1 : 4-dimethylhexahydrobenzene have been synthesised by passing the corresponding xylenol with excess of hydrogen over reduced nickel heated to 190—200° (Sabatier and Mailhe, *Comptes Rendus*, 1906, cxlii., 553). In the cases of the xylenols with the methyl groups in the 1 : 2- and 1 : 3-positions, large amounts of the corresponding xylenes are formed, whereas with the 1 : 4-compound the formation of xylene was not observed, and the hydration mixture consisted of 90 per cent of the desired alcohol and 10 per cent of the corresponding ketone.

In the last Report (1905, p. 155) the hydrogenation of the three cresols was referred to (*Comptes Rendus*, 1905, cxl., 350). Sabatier and Mailhe have now shown that by treating the ketones obtained in this manner with magnesium methyl iodide, good yields of the three following hydroxydimethylhexahydrobenzenes are obtained (*Comptes Rendus*, 1905, cxli., 20) :—



Cyclohexylmercaptan has been described by Borsche and Lange (*Ber.*, 1906, xxxix., 392) as a highly refractive liquid of mercaptan-like odour, formed when the sulphon

$$CH_2\begin{matrix}<CH_2-CH_2\\ CH_2-CH_2>\end{matrix}CH.SH,$$

chloride, obtained by the action of phosphorus pentachloride on potassium hexahydrobenzenesulphonic acid, is reduced with zinc and hydrochloric acid.

Cyclohexylxanthate, $C_6H_{11}.S.CS.OC_2H_5$ (*Ber.*, 1906, xxxix., 392), is formed by the interaction of potassium xanthate and cyclohexylbromide, and is converted by ammonia into cyclohexylmercaptan and xanthamide.

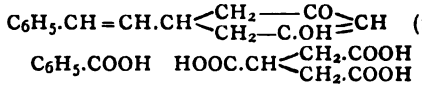
*Amines.*—Sabatier and Senderens (*Comptes Rendus*, 1905, cxl., 482) have shown that by the hydrogenation of

* Report of the Committee, consisting of Dr. E. Divers (Chairman), Professor A. W. Crossley (Secretary), Professor W. H. Perkin, Dr M. O. Forster, and Dr. H. R. Le Sueur. Read before the British Association (Section B), York Meeting, 1906.

benzonitrile in presence of nickel at 200°, ammonia and toluene are almost exclusively formed. Frebault (*Comptes Rendus*, 1905, cxl., 1036) now proves that, under modified conditions, the reduction takes place similarly to that of the aliphatic nitriles, and that primary and secondary aromatic amines can be thus obtained. Benzonitrile gives rise to benzylamine and dibenzylamine in approximately equal amounts, and *p*-tolunitrile to *p*-methylbenzylamine and di-*p*-methylbenzylamine.

*Ketones.*—As a further instance of the use of Grignard's reaction, the preparation of cyclohexylacetone may be quoted. Though this substance is not obtainable by the interaction of chlorohexahydrobenzene and ethylsodioacetoacetate, it may be produced by the action of hexahydrobenzylmagnesium iodide on acetaldehyde (Freundler, *Comptes Rendus*, 1906, cxlii., 343).

*Dihydroresorcins.* — Ethyl malonate combines with cinnamylideneacetone (Vorländer and Gröbel, *Annalen*, 1906, cccxlv., 206) to give cinnamylidenedihydroresorcin (10), which on oxidation with potassium permanganate is



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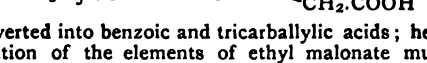
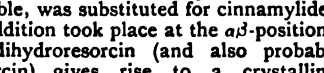
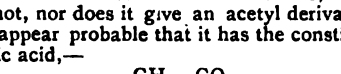


converted into benzoic and tricarballylic acids; hence the addition of the elements of ethyl malonate must have taken place at the $\alpha\beta$-position relative to the carbonyl group. As this addition may be influenced by the tendency to form a six-ring cinnamenylacrylic acid, $C_6H_5.CH{:}CH.CH{:}CH.COOC_2H_5$, where no ring formation is possible, was substituted for cinnamylideneacetone, but again addition took place at the $\alpha\beta$-position.

Dimethyldihydroresorcin (and also probably phenyldihydroresorcin) gives rise to a crystalline and an amorphous oxime (Gittel, *Cent. Blatt.*, 1896, [1], 33). The former can be converted into a dioxime, whereas the latter cannot, nor does it give an acetyl derivative, which makes it appear probable that it has the constitution of a hydroxamic acid,—



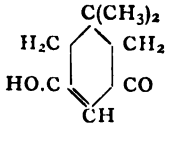
On the other hand, both oximes have faintly acid properties, and may therefore be stereoisomerides. Dimethyldihydroresorcin gives a monophenylhydrazone and also a mono-anilide, which behaves in a similar manner to the



amorphous oxime, in not condensing with a second molecule of aniline to form a di-anilide, nor does it yield an oxime, but it gives an acetyl derivative. The compounds formed by the condensation of dimethyldihydroresorcin with *o*- and *p*-toluidine and α-naphthylamine are also described.

Work of a similar nature, but more comprehensive, has been carried out by Haas (*Journ. Chem. Soc.*, 1906, lxxxix., 187), who shows that dimethyldihydroresorcin (11) condenses with only one molecule of a primary base (ammonia, aniline, or *p*-toluidine), water being eliminated

(11)



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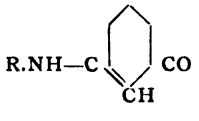

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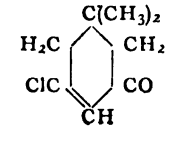

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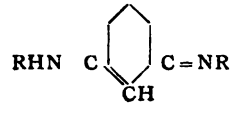
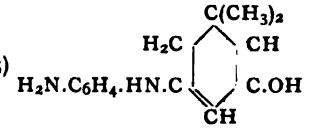


between the hydroxyl group of the dihydroresorcin and a hydrogen atom of the amino-group, to give a compound of the type of Formula 12. On the other hand, chloroketodimethyltetrahydrobenzene (13) reacts directly with two molecules of a primary base, yielding a compound of the type of Formula 14.

Neither dimethyldihydroresorcin nor chloroketodimethyltetrahydrobenzene reacts with secondary amines. The replacement of the hydroxyl group in dimethyldihydroresorcin by a basic group, such as $NH_2$-, $C_6H_5.NH$-, or $C_7H_7.NH$-, causes the remaining ketonic oxygen atom of the dihydroresorcin to become hydroxylic, as shown by the colour reactions of the resulting substances with ferric chloride and their behaviour towards phosphorus trichloride. If, however, the substituting group is rendered more acidic by the introduction of an acetyl group, this second oxygen atom becomes ketonic and is able to condense with semicarbazide. The mono-derivatives produced from dimethyldihydroresorcin can be converted into the di-derivatives directly obtainable from chloroketodimethyltetrahydrobenzene either by condensation with a second molecule of the primary base in presence of zinc chloride, or by the action of the phosphorus haloids.

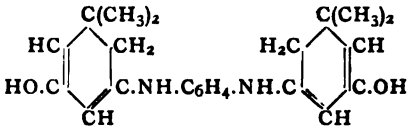
In a second communication (*Journ. Chem. Soc.*, 1906, lxxxix., 388), it is shown that molecular proportions of dimethyldihydroresorcin and a primary diamine (*m*- or *p*-phenylenediamine) interact to give an 80 per cent yield of the simple condensation product (15), but, in addition,

(15)



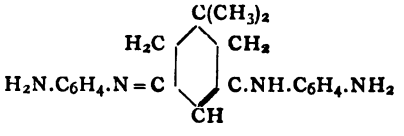
there is also formed a small amount of the compound (16)

(16)



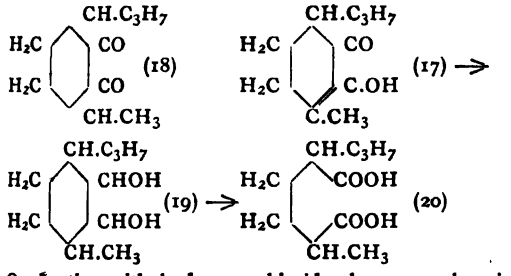
resulting from the condensation of two molecules of the dihydroresorcin with one of the diamine. The compounds of Formula 15 function as di-acid bases, giving rise to dihydrochlorides, which react with one molecular proportion of platinic chloride to form platinum salts; they are insoluble in water, but dissolve in alcohol to form neutral solutions which produce with ferric chloride a reddish brown coloration; with acetic anhydride they yield monoacetyl derivatives only, which still give a colour reaction with ferric chloride. The di-substituted phenylenediamines (16) are also di-acid bases having a neutral reaction; they are not acetylated by boiling with acetic anhydride, and may be re-crystallised without change from glacial acetic acid; in alcoholic solution they give with ferric chloride a reddish yellow colour.

Chloroketodimethyltetrahydrobenzene condenses at once with two molecules of *m*-phenylene diamine to give the hydrochloride of a base having formula—



During the investigation of the above-mentioned substances it has been shown that the numbers obtained for the percentage of nitrogen were from 2 per cent to 5 per cent too high for the calculated values (*Journ. Chem. Soc.*, 1906, lxxxix., 570). This discrepancy has been proved to be due to the presence of marsh gas, and a method for obviating the difficulty has been devised.

A further investigation of buccocamphor (diosphenol) has shown it to possess a constitution closely resembling the dihydroresorcins (Semmler and MacKenzie, *Ber.*, 1906, xxxix., 1158). It has the molecular formula $C_{10}H_{16}O_2$, and is a ketone alcohol (17) or diketone (18) containing a hexamethylene ring, with methyl and isopropyl groups in the 1 : 4-position, and in which the double bond must be attached to the carbon atom carrying the methyl group.



On heating with hydrogen chloride, buccocamphor is quantitatively converted into thymol, and on reduction with sodium in alcoholic solution it yields a glycol (19), which on oxidation, is converted into α-methyl-α'-isopropyladipic acid (20), thus definitely establishing its constitution. The authors have succeeded in synthesising buccocamphor by treating hydroxymethylenementhone with ozone.

*Acids.*—Ketohexahydrobenzene condenses with ethyl bromoacetate under the influence of magnesium to give ethyl cyclohexanolacetate (Wallach, *Annalen*, 1905, cccxliii., 40) :—

$$CH_2<^{CH_2-CH_2}_{CH_2-CH_2}>C(OH).CH_2.COOC_2H_5.$$

By loss of water and subsequent hydrolysis, cyclohexeneacetic acid is obtained, which, when oxidised with potas-

$$CH_2<^{CH_2-CH}_{CH_2-CH_2}\!\!>C.CH_2.COOH$$

or—

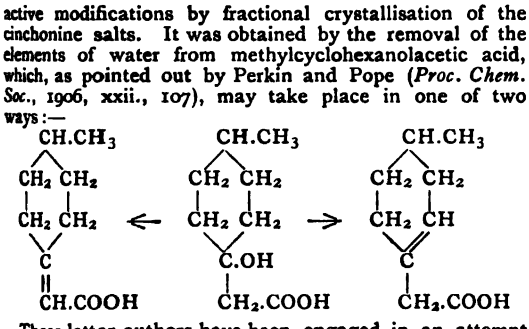
$$CH_2<^{CH_2-CH_2}_{CH_2-CH_2}>C=CH.COOH$$

sium permanganate, gives a non-aldehydic compound containing seven carbon atoms.

Marckwald and Meth have described an acid believed by them to be 1-methyl*cyclo*hexylideneacetic acid (*Ber.*, 1906, xxxix., 1171). It melts at 41°, and has been resolved into

$$CH_3.CH<^{CH_2-CH_2}_{CH_2-CH_2}>C=CH.COOH$$

active modifications by fractional crystallisation of the cinchonine salts. It was obtained by the removal of the elements of water from methylcyclohexanolacetic acid, which, as pointed out by Perkin and Pope (*Proc. Chem. Soc.*, 1906, xxii., 107), may take place in one of two ways :—



These latter authors have been engaged in an attempt to prepare a substance which, while not containing an asymmetric carbon atom, is yet capable of existing in optically active modifications, and one of the substances selected for examination was methyl*cyclo*hexylideneacetic acid. This was prepared from ethyl hexahydro-*p*-toluate as starting point, and which on reduction with sodium and alcohol gives hexahydro-*p*-tolylcarbinol,—

$$CH_3.CH<^{CH_2-CH_2}_{CH_2-CH_2}>CH.CH_2OH.$$

This carbinol is readily converted into hexahydro-*p*-tolyl bromide, which, when heated with potassium cyanide and the product hydrolysed, yields hexahydro-*p*-tolylacetic acid,—

$$CH_3.CH<^{CH_2-CH_2}_{CH_2-CH_2}>CH.CH_2.COOH.$$

Bromine acts on the corresponding acid chloride with formation of α-bromohexahydro-*p*-tolylacetic acid, and the ester of this bromo-acid is decomposed by boiling with diethylaniline into hydrogen bromide and ethyl methyl-*cyclo*hexylideneacetate. On hydrolysis, the free acid is obtained, melting at 70—71°, and the method of preparation leaves no doubt that its constitution is represented by the formula—

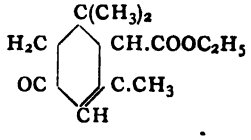
$$CH_3.CH<^{CH_2-CH_2}_{CH_2-CH_2}>C=CH.COOH.$$

The acid described by Marckwald and Meth is possibly the isomeric acid,—

$$CH_3.CH<^{CH_2-CH}_{CH_2-CH_2}\!\!>C-CH_2.COOH.$$

Chloro- or iodohexahydrobenzene reacts with ethyl sodiocyanacetate or ethyl sodiomalonate in xylene solution, and from either of the resulting condensation products cyclohexylacetic acid may be obtained on hydrolysis (Freundler and Damond, *Comptes Rendus*, 1905, cxli., 593).

Ethyl isophoroncarboxylate (D.R.P. 148080), obtained by the condensation of ethyl isopropylideneacetoacetate and ethyl sodioacetoacetate, is a δ-ketonic ester with the following constitution (Merling, *Ber.*, 1905, xxxviii., 979) :—



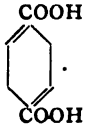
By reduction with sodium and alcohol, a mixture of stereoisomeric hydroxy acids is produced, which does not consist of one cis- and one trans-acid, as stated in the patent, but of three pairs of cis-trans-isomeric acids, in all therefore of six acids, all of which have been isolated. By heating alone or with dehydrating agents three different stable crystalline lactones were obtained, showing that in the parent ketonic acid the carboxyl and carbonyl groups occupy a para-position relatively to one another. A further proof of this is afforded by the fact that the lactones are oxidised by Beckmann's solution to three stereoisomeric dihydroisophoroncarboxylic acids, which distil without decomposition *in vacuo*, and do not lose carbon dioxide on heating to 200° in air.

Abati and Bernardinis have isolated two new hydrophthalic anhydrides by the reduction of sodium phthalate with sodium amalgam (*Journ. Chem. Soc.*, Abst., 1905, [1], 599). Cis-$\Delta^3$-tetrahydrophthalic anhydride crystallises in white scales, and on heating to 220° to 230° is transformed into $\Delta^1$tetrahydrophthalic anhydride.

$\Delta^1$ : 3-Dihydrophthalic anhydride melts at 58°, and on heating to 225° is transformed into another anhydrine, which could not be identified.

The trans-hexahydroisophthalic acid, previously described (*Journ. Chem. Soc.*, 1891, lix., 808) as melting at 120° to 122°, has been proved by Perkin and Goodwin (*Ibid.*, 1905, lxxxvii., 841) to be a mixture of the cis- and trans-acids, which can be separated by dissolving in a considerable excess of ammonia, and heating for some hours with calcium chloride, when a quantity of the calcium salt of the cis-acid is obtained. After repeating this process several times, the mother-liquor yielded pure trans-hexahydroisophthalic acid melting at 148°. When the pure trans-acid is treated with phosphorus pentachloride and then bromine, 1 : 3 - dibromo-trans-hexahydroisophthalic acid is produced, which, on treatment with methyl alcoholic potash, gives a dihydroiso-

phthalic acid, whose constitution is probably represented by the formula—




It is isomeric with the acid previously obtained from 3 : 4-dibromohexahydroisophthalic acid by similar treatment.

Chlorohexahydrobenzene readily forms a Grignard compound with magnesium (Borsche and Lange, *Ber.*, 1905, xxxviii., 2766), which, when acted on with dry sulphur dioxide, yields magnesium hexahydrobenzenesulphinate. This latter substance, on oxidation with potassium permanganate, gives a mixture of dicyclohexanesulphone and the potassium salt of hexahydrobenzenesulphonic acid. The free acid crystallises from alcohol, melts at 90° to 92°, and gives a corresponding acid chloride, anilide, and ethyl ester.

## THE LATEX OF *DYERA COSTULATA*.*

By Prof. W. A. TILDEN.

Early in May last I received from a correspondent in Singapore a sample of the latex of *Dyera Costulata* to which a small quantity of ammonia had been added to keep it from coagulating. It remains a white creamy fluid of specific gravity 1·11, miscible with water. I am without information as to the reaction of the original fluid with test-papers. It is rare to find vegetable juices exhibiting an alkaline reaction, but I am disposed to believe that this latex in the fresh state possesses slight alkalinity, as it is coagulated sooner or later by all acids without agitation. But, as in milk, the suspended particles unite when the liquid is violently shaken. It is also coagulated by admixture with strong solution of common salt, and when warmed with an equal volume of 20 per cent solution of soda.

Heated to a temperature of 70° to 80° C. solidification does not occur except at the surface, where a skin forms, and even on boiling no immediate change takes place.

The milk as received yielded about 44 per cent of solid by coagulation with hydrochloric acid.

The aqueous liquid filtered from the coagulum contains a small quantity of a substance which reduces Fehling's solution only after it has been heated for a few minutes with hydrochloric acid. Whether this is cane-sugar or a glucoside I have not yet ascertained. The amount of proteid present is very small.

The coagulated solid is tough, but contains only a very small quantity of rubber substance, as it is almost entirely soluble in alcohol or acetone.

*Dyera Costulata* is reputed to be the botantical source of the white gutta now quite familiar under the name of "Pontianak," the port in Borneo from which it is exported to Europe. Pontianak contains a small quantity of rubber mixed with two or more substances, of which at least one, melting-point 173°, is crystallisable from alcohol. This analysed in my laboratory gave as the mean of several combustions C = 81·2 and H = 11·0 per cent. This corresponds roughly to a formula $C_{14}H_{22}O$, which requires C = 81·5, H = 10·7. The molecular weight, 206, required for this is, however, much less than the result of observations on the freezing-point of the benzene solution. These gave as a mean 322.

The crystalline substances contained in gutta have been supposed to be related to lupeol, but this can hardly be said to be definitely established.

Likiernik (*Ber.*, xxiv., 185) found in lupeol 84·01 C, 11·38 H, and melting-point 204°. As to the process by which caoutchouc and the associated substances are formed in the latex, nothing seems to to be known, but I incline to the view that they are probably formed in the laticiferous vessels by the rupture of molecules of compounds of the nature of tertiary alcohols with the production of water and the hydrocarbon or other substance. The readiness with which terpin splits into terpineol and water by the action of minute quantities of acid is an analogous process.

*Note added August*, 1906.—My attention has since been drawn by Professor P. van Romburgh to a paper of his in the *Proceedings of the Royal Academy of Sciences of Amsterdam* for June, 1905, in which lupeol acetate and cinnamate are recognised as constituents of gutta-percha and pontianak.

* A Paper read before the British Association (Section B), York Meeting, 1906.

## UTILISATION OF NITROGEN IN AIR BY PLANTS.*

By T. JAMIESON, F.I.C., Aberdeen.

The question whether plants can absorb and assimilate the free nitrogen of air is perhaps the most important question of science bearing on agriculture. It has occupied the attention of eminent chemists from early times, in particular Priestley, De Saussure, Boussingault, Ville, Liebig, and finally, Lawes, Gilbert, and Pugh conjointly at Rothamsted. The question has been answered in the negative, and in the positive almost alternately, but on the negative results of experiments by Boussingault and Lawes the doctrine generally prevails—that plants can not absorb and utilise free nitrogen.

Doubts, however, have frequently arisen in regard to the soundness of this doctrine, in consequence of what appeared to be contradictions given by the general practice of agriculture, as well as by systematic trials, and also by a consideration of Nature's methods and of natural or wild growth. In particular, it was contradicted by the circumstance frequently found, that if legume crops were alternated with cereal crops, good crops were obtained for many years in succession without the application of any nitrogenous manure, and without lowering, but rather increasing, the nitrogen in the soil, and that although large quantities of nitrogenous matter were carried off the land yearly in the form of crops.

In 1885, Atwater, in America, found by careful trials that legumes did acquire nitrogen from air, but he could give no explanation of the nature, or of the seat of the process; consequently, perhaps, his results have been almost ignored, the opposite idea having gained so firm a hold.

In 1887, Hellriegel and Wilfarth in Germany confirmed this power of legumes, but they added the explanation that it was due to the agency of the numerous nodules that are usually found on the roots of legumes. They affirmed that these nodules contain bacteria which, they assumed, absorb the nitrogen of the air in the soil, and change it into a form on which the legumes can thrive, the bacteria themselves being at the same time nourished by the legume, thus indicating a mutual aid or symbiotic existence. It has since, however, been shown by several observers that what were regarded as bacteria are only disaggregated particles of abnormal tissue, and this being the case, bacterial action does not explain the method of absorption of nitrogen. Further, and in particular, it has been found by Franck, in Germany, that if legumes are grown in sterilised soil, no nodules are formed; and yet there is the same evidence of absorption of nitrogen. It thus appears that the absorption must be performed by the

* Abstract of a Paper read before the British Association (Section B), York Meeting, 1906.

plant itself. Therefore, if the legume plant can of itself absorb nitrogen, it appeared probable that all plants can do so to a lesser or a greater extent, but no satisfactory evidence to this effect existed, although Franck found a small grain on colza and oats.

Franck also found that the amount of nitrogen absorbed varied in accordance with the vigour of the plant, and pointed out that the conclusions of Boussingault and Lawes were vitiated by being based on "atrophied" plants. Their experimental plants were grown under abnormal conditions, *i.e.*, in water or sterilised soil and confined air, and in each case they were so very small that they must have been feeble or sickly, and therefore not fitted to display the abilities of vigorous plants grown under natural conditions.

Atwater's trials, on the other hand, were made under more natural conditions, *i.e.*, in sterilised sand, the plants being exposed to air; acting thus, vigorous plants were produced and he found a material gain of nitrogen. His trials also confirmed Franck's conclusion, that the more vigorous the plant the larger the gain in nitrogen.

In view of Hellriegel's investigations, which opposed the conclusions of Lawes and Boussingault, Lawes made further trials and admitted the gain in nitrogen by legumes, adopting, however, the nodule or bacterial explanation of it. But Franck's trials, and Atwater's trials on plants without nodules, obviously nullifies that explanation, and necessitates the conclusion that the plants themselves in one way or other absorb nitrogen. This being the case, Lawes' conclusion, and consequently also Boussingault's conclusion, is undermined by these and by Lawes' own subsequent trials, and the prevailing doctrine that plants cannot absorb and utilise nitrogen from air is thus deprived of support.

Both Atwater and Franck, however, failed to find the part of the plant or the method by which the nitrogen was absorbed; but Franck, who had thoroughly investigated and considered the subject in all its bearings, concluded by anticipating that an organ would be found on plants fitted to absorb nitrogen.

It is the finding of this organ that is the special subject of the paper now submitted. That the organ has not been previously found is probably due to the very great difficulty in detecting it on the mature cultivated plants, and more especially on the legumes, to which, as the most nitrogenous of cultivated plants, attention would in all probability have been the first and specially directed. It so happened that several years ago I had analysed a large number of wild plants, and found that some of them contained a much larger proportion of nitrogen even than legumes; if therefore a nitrogen absorbing organ existed it would probably be conspicuous on such plants, and by far the most likely part of the plant to bear them would be the leaves. These anticipations turned out to be correct. On examining the plant highest in nitrogen, namely, *Spergula arvensis* (or common spurrey), organs were observed whose peculiar structure appeared admirably adapted for nitrogen absorption in the form of short, blunt, horizontally sectioned hairs hoisted up into the air, the highest section of which was found to contain, in the early stage, greenish chlorophyll-like matter, which was separated from the air only by a most delicate film. The application of the usual tests for albumen showed very conclusively that these green tips or highest sections were manufactories of albumen, for while the youngest ones failed to respond to the tests, more advanced hairs responded distinctly; different stages were found corresponding to the age of the hair, some responding to the tests very conspicuously, others were found to be gorged with albumen, and still older hairs were seen to be discharging the semi-solid albuminous matter down through the lower sections. A circular space surrounds the sections, and into this space is continuously discharged liquid albuminous matter, which passes into the internal channels of the leaf, the sections forming the purpose of an ingenious filter.

It remained to ascertain whether similar organs exist on the other wild plants high in nitrogen, viz., chickweed and nettle, and examination clearly proved their existence in abundance. They showed the same essential characters as above described, but varied more or less in form. Familiarity with the character of the organ being thus acquired, cultivated plants were examined, choosing in the first place the bean, but no sign of the organ could at first be detected on the matured leaves. Ultimately one was found nearly embedded in the tissue; the difficulty in finding it explained the failure of other investigators to discover the method or organ of absorption. When, however, a seedling plant was grown, the youngest leaves showed on examination essentially the same organs, not occasionally, but in profusion. It is on the youngest leaves of plants that the organs have to be sought, and this is consistent with the purpose in view, for albumen is chiefly required at the earliest stage of the plant life; further, it is required only in small proportion, composing as it does only about 0·2 per cent of growing plants, and the young and more highly nitrogenous leaf is thus able to provide the necessary quantity for the matured leaf.

Other cultivated plants were then examined, and in every case organs showing the same essential characters were found, viz., on turnip, rape, potato, beet, carrot, lettuce, chicory, tobacco, geranium, petunia, balm, daisy, and prunella. They were also found even upon representatives of plants having dense, hard, glossy leaves; for instance, they were found in profusion on the bud-leaves of a holly (*Holly laurifolia*), and of a species of pine (*Abies migra*). These organs may conveniently be referred to as "albumen generators."

A remarkable confirmation of the soundness of the solution of the question was then got by finding its harmony with the experience of general practice and of scientific experiments. For it is found in general practice that the dicotyledons cultivated, and in particular legumes and turnips, though they contain a comparatively large quantity of nitrogen, require little nitrogenous manure, and are often retarded or injured by it, a fact that is now explained by the abundance of their albumen generators, which provide them with a sufficient quantity. On the other hand, the cultivated monocotyledons, such as cereals and grasses, though containing less nitrogen, urgently demand nitrogenous manures, and this is now fully explained by the comparative absence of "albumen generators." Thus, on barley, oats, and several grasses, at all stages of their growth, not a single albumen generator could be found, and the only available means of absorption, and that only to a small extent, appears to be the thin edge of the leaf in their youngest stage and the leaf-sheath.

It thus appears that all plants are able in various degrees to absorb the free nitrogen in air, and to transform it into albumen, by means of these specialised organs on their youngest leaves. This conclusion harmonises with scientific experiments, with practice, and with the natural growth of plants on the large scale, and thus presents a contrast to the many contradictions arising under the opposite doctrine.

Summing up:—Experimental chemical evidence has been given by Atwater's and Franck's trials that there is a gain of nitrogen in legumes bearing no nodules, the only source of which can be the air, and a smaller gain has been found by Franck in other plants.

Chemical evidence has been given by analyses which have shown that the leaves, deprived of their stalks, are richer in nitrogen than other parts of the plant, and that the youngest leaves bearing the albumen generators are fully one-third richer in nitrogen than the matured leaves.

Finally, biological evidence has been provided by microscopic examination. Thus there has been (*a*) pointed out an organ admirably situated and specially adapted for the absorption of nitrogen; (*b*) shown that this organ exists on all plants examined, including widely different families; (*c*) proved that these organs exists abundantly on highly nitrogenous plants, and sparsely on plants poor in nitrogen; (*d*) demonstrated that this organ is at first void

of, and becomes gradually gorged with, nitrogenous matter, and then disgorges the matter into the plant generally; (*e*) proved by recognised chemical tests that this matter is nitrogenous; and finally (*f*) shown that this solution of the problem conforms to the numerous results of experiments and to the experience of practice which were otherwise inexplicable.

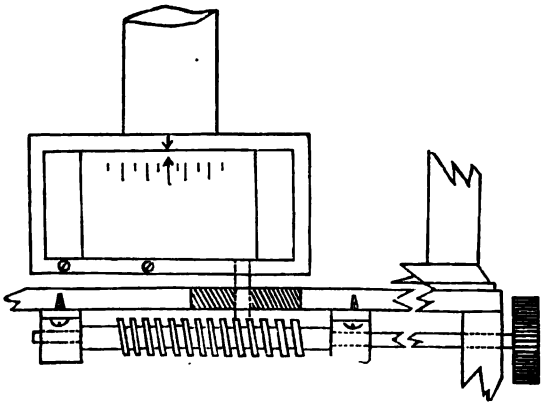
## NEW SYSTEM OF ZERO FOR CHEMICAL BALANCES.

By JOHN McDOWALL, F.C.S.

Before a balance is used for weighing the zero has to be taken, which is done by calculating the mean point on the scale through which the pointer moves. This method of taking the zero, although exact, is tedious, and requires much time, so much so that technical chemists to whom, as a rule, time is more valuable than extreme accuracy, usually set the pointer of the balance by means of the counterpoising screws at the centre of the scale every now and then, and work with that as zero, neglecting the small error that arises therefrom until it grows so great that the screws need re-adjusting.

It seemed that an improvement in this direction was desirable, and I have devised and tested an instrument by means of which the most sensitive balance can be set with perfect precision exactly in the centre of the scale in a few seconds without even opening the door of the balance case.

The ordinary ivory scale in the balance is replaced by a frame of brass, in which slides the scale in grooves in the frame as shown in the diagram.



The right-hand bottom corner of the scale is prolonged into a finger which goes through a slit in the side of the frame and then through another slit in the bottom of the balance.

The end of the finger is contracted into a tooth, and this engages with a screw, by the rotation of which the scale can be slid along the frame.

The rod of which the screw forms the centre is continued through a hole in the side of the balance and ends in a milled head similar to that used for releasing the pans.

The diameter of the screw spindle is made smaller about an inch from each end of the screw, so that the brackets which slip over it are arrested at the shoulder so that the spindle cannot move longitudinally and can only rotate.

When the milled head is revolved the screw rotates and moves the end of the finger along so that the graduated scale can be moved from one end of the frame to the other, the slits in the frame and bottom of balance being long enough for this purpose. Suppose now the balance has to be set at zero: the centre of the scale is set in the centre of the frame and the pans are released, and after one or two preliminary swings the zero is taken.

Suppose the zero is a division or so to the left, the operator moves the scale through what he estimates to be a division by turning the milled head, and then takes another reading, using the eyes alone.

If the zero is still a little to the left he moves the scale on in that direction and takes another reading, and so on, until the pointer swings exactly the same number of divisions from each side of the centre line in the scale. The balance is now ready for use, and the operation has only taken a fraction of a minute.

When the pointer is several divisions out from the centre of frame the counterpoising screw may be given a turn so as to bring it roughly back to the centre, and then it can be finely adjusted by means of the sliding scale.

The instrument places in the hands of the technical chemist and assayer a means by which he can weigh as exactly as by the old method of calculating the zero, and no time is lost in the operation.

The balance on which the instrument was tested had a wooden bottom and a drawer, but it could easily be fixed to those having plate-glass bottoms; the slit in such a case would need to be ground out with a thin steel wheel and emery powder.

The instrument was made from my drawings by Becker and Co., and as the drawings are still in the possession of the firm there should be no difficulty in getting the article properly made, although the dimensions of the special balance would need to be given.

## SOME DIETETIC PROBLEMS.*

By ROBERT HUTCHISON, M.D., F.R.C.P.

The lecturer began by pointing out the great awakening of interest in Dietetic Problems which had taken place in recent years, and which had exhibited itself on the practical side in the promulgation of various systems of diet, more or less heterodox, for which their advocates claimed many advantages both economic and hygienic. With these systems the lecturer did not propose to deal, but rather to make clear the nature of the scientific problems which lie at the basis of the whole subject, and to which answers must be furnished before any acceptable system of practical dietetics could be formulated. In order to approach the subject in the clearest way some elementary preliminary matters had first to be considered. The two functions of food—(1) as a source of energy, and (2) as replacing waste—were therefore emphasised. Of the constituents of ordinary articles of food the proteids, carbohydrates, fats, water, and mineral matters, along with gelatin and alcohol, were alone of nutritive value, and in considering subsequent problems the first five of these need alone be taken into account. Emphasis was laid upon the fact that the proteids, mineral matters, and water are the nutritive ingredients which are concerned in replacing waste, whilst the proteids, carbohydrates, and fats are the chief energy-yielding constituents of the food. Reference was made to the large or kilo-calorie as the unit of energy employed in dietetics, and the caloric value of some typical foods was exhibited by the aid of a diagram. The lecturer then passed to the first of the problems which had to be considered, viz., how much energy (in calories) must the daily diet contain? It was pointed that a reply to this question might be arrived at (1) scientifically, by estimating the daily expenditure of energy in different forms by a subject confined in a respiration-calorimeter, or (2) empirically, by calculating the average amount of energy (in calories) contained in the freely chosen diets of a number of individuals doing a moderate amount of work, and whose weight was stationary. In this way such a balance sheet as the following could be constructed.

* A Discourse delivered at the Royal Institution, March 9, 1906.

*Metabolic Balance Sheet (Man of 56 Kilos.).*

| | | |
|---|---|---|
| Expenditure of Energy— | | |
| 1. Internal work (heart, respiration, heat-production) .. .. .. .. .. .. | | 1550 cals. |
| 2. Digestive work .. .. .. .. .. .. | | 240 „ |
| 3. External or muscular work— | | |
| (*a*) Actual work done .. .. | 250 | |
| (*b*) Increase under (1) .. .. | 590 | |
| | | 840 „ |
| Total .. .. .. .. .. .. | | 2630 „ |
| Income as Food— | | |
| 118 grms. proteid.. .. .. .. .. .. .. | | 484 „ |
| 56 „ fat .. .. .. .. .. .. .. | | 521 „ |
| 500 „ carbohydrates .. .. .. .. .. | | 2050 „ |
| Total .. .. .. .. .. .. | | 3055 „ |

(Balance: 425 cals. = 45 grms. fat, or 2 ozs. adipose tissue).

Attention being first confined to the expenditure side of the balance sheet, the nature of the outgoings of energy in each item under this heading was briefly explained. It was pointed out that the exact amount of energy expended under each head varied greatly in different circumstances and individuals.

1. The amount of "internal work" depended upon body-weight, the proportion of fat and muscle, the age, and most of all, upon the extent of body-surface. The latter factor was of the greatest importance as determining heat loss, and variations in the amount of energy consumed by different persons could be largely explained by it. This was illustrated by the fact that if we stated the amount of energy required at different ages in terms of body-surface, the results were surprisingly uniform.

2. The amount of the digestive work varied with the composition, and especially with the bulk of the food. The influence of bulk was so important that it had been calculated that if a horse were fed upon hay alone, 48 per cent of the energy in the hay was expended in its digestion.

3. The influence of external work upon expenditure required little explanation, but stress was laid upon the large increase which even slight degrees of work might entail. Thus, 12 per cent more of energy was expended when standing at attention than when standing at ease, whilst an hour's brisk walk increased the output of energy by 260 cals. Further, one must remember that any increase in external work increased also the expenditure under all the items classed as "internal work" as well. Apart from such variations as these, the question was raised whether there might not be individual variations in metabolism of which we are not yet able to give an exact account. Temperament, for example, was of importance, as determining the performance of superfluous movements, and in the rate at which muscular efforts took place. Apart from this, it was possible that some individuals might be "more economical machines" than others, producing, for instance, more work and less heat for a given supply of energy. The human body was certainly not a thermodynamic machine; it might be thermo-electric, chemico-electric, or chemico-dynamic, or even transform energy in some as yet unknown way, and so long as we were ignorant of its exact mode of working, the possibility of variations in the economy of the machine could not be absolutely denied.

Passing to the income side of the balance sheet, it was shown that this must be determined empirically, by a study of the composition of the diets actually consumed by persons of stationary weight under different conditions. A selection of the results yielded by such study was exhibited with the aid of a diagram, and from them the following "standard diet" had been deduced for a man of average weight, doing a moderate amount of work:—

| | | | |
|---|---|---|---|
| Proteid .. .. .. | 118 grms. | = | 484 cals. |
| Fat .. .. .. .. | 56 „ | = | 521 „ |
| Carbohydrates . .. | 500 „ | = | 2050 „ |
| Total energy .. | | | 3055 „ |

Assuming that the individual whose expenditure was studied in the above balance sheet was put upon such a diet as this, he would have a positive balance of 425 calories = 45 grms. fat, or 2 ozs. of adipose tissue daily. The question was raised whether this balance was necessarily stored as fat, or whether it might not circulate in the blood in some unknown form, and be broken down in abnormal ways giving rise to manifestations of disease. Upon the hypothesis that this could take place Dr. Francis Hare had founded his doctrine of Hyperpyraemia.

Assuming the standard diet above detailed to be that usually consumed, the further question arose, could not economy be effected? The lecturer suggested two directions in which this was possible:—(1) By a lessened heat production, (2) by a reduction of body weight. It was pointed out that in civilised conditions fat had ceased to be of value as a reserve of food, whilst the mere transport of several pounds of it entailed a considerable expenditure of energy. How much fat it was advisable to harbour in the body was an individual question to which no general reply could be given; it depended upon the "fighting weight" of the individual, *i.e.*, the weight at which his mental and physical efficiency was greatest.

Summing up, the lecturer pointed out that no definite reply could be given to the problem how much energy must be supplied in the daily ration owing to the great variations in expenditure above described. Empirical observation showed that 3000 calories was the average amount taken in, but the trend of scientific opinion was in favour of the view that this was perhaps needlessly liberal.

Turning to the second great problem underlying the science of dietetics—how much proteid is required daily in order to make good the daily waste of the body—the lecturer pointed out that it was impossible to construct a balance sheet for proteid in the body as could be done for energy, for the reason that the organism always tended to get into nitrogenous equilibrium on any quantity of proteid which was supplied up even to the limits of digestive capacity. It was shown by the aid of a diagram that, if an equal number of molecules of proteid, carbohydrate, and fat were brought into the neighbourhood of a cell, the cell did not break down equal proportions of each, but that the highest percentage of proteid molecules was destroyed; next in order of destructibility came carbohydrate, and last fat. This was probably due to the greater instability of the proteid and carbohydrate molecules, an instability which, in the case of sugar at all events, was the result of the presence in the molecule of an aldehyde or ketone group. If, on the other hand, a small number of proteid molecules and a relatively large number of those of carbohydrate and fat were brought simultaneously within reach of the cell, the mass influence of the more numerous molecules asserted itself, and, to use a simile, so distracted the attention of the cell that some of the proteid molecules escaped destruction. Hence the term "proteid sparers" as applied to carbohydrates and fats. It was pointed out that the theory of proteid sparers might furnish a reconciliation between apparently opposed systems of diet which yet seemed to give the same therapeutic results. It explained, for instance, how gout, which was presumably due to the presence in the blood of imperfectly oxidised proteid, might be treated successfully either upon a diet containing very little total proteid, or upon one in which the proteid sparers were largely excluded (*e.g.*, the "Salisbury" system). Another deduction which might be made from the theory was that it must always be easier to attain nitrogenous equilibrium upon a minimum supply of proteid if the latter was taken along with carbohydrates, so that both nutritive ingredients came under the action of the cells simultaneously.

Thus, to take most of the animal part of the diet at one meal and carbonaceous foods at others was wasteful of proteid, whereas a vegetarian diet in which carbohydrates and proteid are so intimately mixed that they reach the tissues at the same time, was that on which it was most easy to attain nitrogenous equilibrium on a relatively low proteid intake.

It followed also from the doctrine of proteid sparers that the amount of proteid necessary for the establishment of nitrogenous equilibrium must vary with the composition of the diet as a whole. It might be supposed that the nitrogenous output of fasting would provide an index of the proteid minimum. This, however, was found by experiment not to hold good, for proteid seemed so to stimulate the vital activity of all the tissues as to increase their power of oxidation; hence, if nitrogenous equilibrium is to be attained more proteid must be taken than is the equivalent of the nitrogen output of fasting.

The question for practical dietitians, however, was not what is the proteid minimum, but what is the proteid optimum? This question could only be solved empirically by observation of the amount of proteid actually consumed by persons in nitrogenous equilibrium. From such observations Voit had fixed the proteid optimum at 118 grms. daily. The lecturer then described the experiments of Chittenden, which seemed to show that health could be maintained on a much lower amount than this, even on as little as 60 grms. Did Nature furnish no hint as to the correct standard? It was suggested that in the proportion of proteid in human milk such guidance might be found. Assuming that an infant of six months consumed milk to the value of 578 calories daily, containing 14 grms. of proteid, and that the average energy-value of an adult diet was 3000 calories, it followed that if the adult was to take in the same proportion of his energy in the form of proteid as the child does, the standard for the adult would be about 74 grms. of proteid, it being further assumed that growth in the child might be set off against the greater wear and tear in the adult. The results of this method of attacking the problem were in striking harmony with those arrived at empirically by Chittenden.

The lecturer then touched upon the relative advantages and disadvantages of a low nitrogenous intake, emphasising the possible value of a proteid-rich diet in increasing the powers of resistance to infective disease, especially tuberbulosis, and the danger of having no margin of circulating proteid to draw upon in case of emergency.

Summing up the reply to the second problem, it was shown that the proteid optimum must vary greatly in different circumstances and individuals, and in accordance with the composition of the diet as a whole, but that it probably stood nearer to the proteid minimum than had hitherto been supposed. The old and new dietary standards were then contrasted as regards both energy and proteid, and, in conclusion, the bearings of an acceptance of the new standard upon such practical systems of diet as vegetarianism were briefly indicated.

## PREPARATION OF PURE ETHYL ALCOHOL.

By J. BISHOP TINGLE.

Commercial "absolute" alcohol always contains water, sometimes as much as 1 to 2 per cent; in addition to this, aldehyde is frequently present in varying quantity. The methods of purification in general use in laboratories, such as distillation over lime, baryta, sodium, &c., although adequate to remove the water, fail to affect the aldehyde, and it cannot be eliminated by fractionation. The problem of its removal has been attacked recently by L. W. Winkler in the following manner (*Ber.*, 1905, xxxviii., 3612):—Silver oxide, prepared from the nitrate, is well washed and dried at the ordinary temperature. It is then triturated with a little of the alcohol and the thin paste added to the remainder. The quantity of oxide used depends, of course, on the particular sample of alcohol; it need not exceed a few grms. to the litre, and may be less. To neutralise the acetic acid which is produced potassium hydroxide, 1 to 2 grms. per litre, is added; the mixture is frequently shaken and allowed to remain for several days at the ordinary temperature, until a portion of the alcohol fails to give the test for aldehyde with ammoniacal silver solution.

The author recommends metallic calcium, in the form of filings, for the removal of water from alcohol; 20 grms. are usually sufficient to dehydrate 1 litre of commercial "absolute" alcohol. The substances are mixed, and boiled in a distillation flask with a reversed condenser, and then distilled; cork connections must not be used. The product is 99·9 per cent pure. A second treatment with 0·5 per cent of its weight of calcium appears to remove the last trace of water, because a third treatment, also with 0·5 per cent of calcium, was found to produce no further change. Certain physical properties of alcohol, purified in this manner and fractionally distilled, were determined with the following results:—Sp. gr. at 0° = 0·80629, at 10° = 0·79787, at 15° = 0·79363, at 20° = 0·78937; these figures are reduced to a vacuum, and referred to water at 4°. The corresponding values given by Mendeleeff are 0·80625, 0·79788, 0·79367, and 0·78945, respectively. The boiling-points are 77·81° (743·5 m.m.), 78·20° (754·9 m.m.), and 78·29° (757·8 m.m.); therefore a difference of 1 m.m. pressure causes a change of 0·034° in the boiling-point. The author mentions two rather curious facts which he has observed in the course of his work. The reaction between calcium and alcohol is the more vigorous the less water is present below 5 per cent, but ordinary alcohol, containing 5 to 10 per cent of water, also attacks calcium with considerable energy. Alcohol absolutely free from water is not nearly so hygroscopic as is usually supposed. For example, 200 c.c. of it were allowed to remain in an uncovered beaker, exposed to the air of the laboratory, during fifteen minutes; it was then found that the amount of water which had been absorbed was less than 0·1 per cent. —*American Chemical Journal*, xxxv., No. 3.

## CORRESPONDENCE.

### KIPP'S APPARATUS.

*To the Editor of the Chemical News.*

Sir,—In 1904 I described an improved form of Kipp's apparatus that I had devised and gave instructions for its use (Chemical News, vol. xc., p. 154). Apparatus thus made have now been in use in my laboratory for over two years without trouble, and with great increase of regularity and economy.

The object of this is to mention two points that have been observed during this time; these are:—

1. The apparatus can be moved about if ordinary care is used. The precaution of keeping it in one place which I suggested two years ago is not necessary.

2. Still further economy of acid can be effected if, when first charged, the space round the standing tube in Bulb 1 is also filled with spent solution as well as Bulb 3.

3. In using my apparatus for hydrogen, hydrochloric acid is preferable to sulphuric on account of the greater solubility of zinc chloride.—I am, &c.,

R. J. Friswell.

Laboratory, 43-45, Great Tower Street, London, E.C.
August 27th, 1906.

**Variations of Electric Resistance of Steels at Temperatures removed from their Transformation-points.**—P. Fournel.—The author has previously ascertained that the resistance of a steel varies in a different manner according as the temperature is above or below the region of the critical-point. He now finds that the electric resistance of a steel increases at first according to a linear law, and then, at a temperature depending on the composition of the metal, the curve rises and becomes parabolic.—*Comptes Rendus*, cxliii., No. 5.

# CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxliii., No. 5, July 30, 1906.

**Compounds of Ammonia with Chloride, Bromide, and Iodide of Gold.**—Fernand Meyer.—The author investigates the action of dry ammonia (both liquid and gaseous) on the halo-aurous compounds. He thus prepares the compounds $AuI.6NH_3$ and $AuBr.2NH_3$. When liquid ammonia acts on aurous chloride a white paste is formed, very slightly soluble in the liquid. At $-28°$, after the excess of ammonia has evaporated, the product obtained corresponds to the formula $AuCl.12NH_3$.

**Some Reactions of Liquid Chlorine.**—V. Thomas and P. Dupuis.—When liquid chlorine acts on iodine a brisk reaction takes place, the trichloride of iodine being produced. The reaction of chlorine on bromine at a low temperature is the same as on iodine. However, when the temperature is raised a decomposition takes place and excess of chlorine is given of, leaving the residue BrCl. When liquid chlorine acts on sulphur, selenium, and their compounds, bodies of the type $MCl_4$ are produced. On arsenic, antimony, bismuth, and gold the same reaction takes place, but not so easily.

**Alloys of Manganese and Molybdenum.** — M. Arrivant.—The author prepares alloys of manganese and molybdenum, and finds that when these bodies contain less than 30 per cent of molybdenum they consist of free manganese associated with one of the constituents, $Mn_6Mo$ or $Mn_4Mo$. These two latter can be isolated by a careful treatment of the alloy with dilute acetic acid.

**Estimation of Ammonia in Water by Nessler's Reaction.**—Albert Buisson.—The author investigates Nessler's reaction for the estimation of ammonia in water, and finds that the reaction is not total, but a state of equilibrium is established between the different elements present. The estimation of ammonia in water, effected by the estimation of the mercury in the precipitate, is inexact, the total ammonia not being precipitated, and the composition of the precipitate not being estimable by any known law. The colorimetric method is acknowledged to be empirical—a portion only of the ammonia sufficing to give the coloration which is the basis of the estimation.

**The Crystalline *l*-Idite of Synthesis.** — Gabriel Bertrand and A. Lanzenberg. — The substance which E. Fischer called *d*-idite, M. Bertrand has found to be identical with sorbierite. The authors now use Fischer and Fay's method, and simplify it by transforming the xylose into a mixture of *l*-gulonic and *l*-idonic acids, and, instead of purifying this latter by brucine salts, they make the gulonic lactone crystallise out and treat the mother-liquor directly with sodium amalgam. They thus prepare *l*-idite accompanied by a little *l*-sorbite, but the latter can be eliminated in part by passing it through benzolic acetal. The *l*-idite, after purification, has the composition $C_6H_{14}O_6$.

**Silver Sulphide, Selenide, and Telluride.** — H. Pélabon.—The author investigates the curves of fusibility of mixtures obtained by melting silver with sulphur, selenium, and tellurium. In all cases the ordinates are the values of the temperature of the beginning of solidification, and abscissæ the value of the proportion, R, of the weight of silver to the total weight of the mixture.

**Washing of Colloidal Precipitates.**—J. Duclaux.—There has always been a considerable analytical error due to the difficulty of washing colloidal precipitates, such as $Fe_2(OH)_6$. The author investigates the matter, and finds that the theory in the case of the iron precipitate, that the ultimate mixture is $Fe_2(OH)_{6\cdot\frac{1}{10}}Fe_2Cl_6$, and that, when this composition is reached, no amount of washing will remove any more chloride, is not strictly true. In reality, an equilibrium is established between the chlorine in the colloid and in the intermolecular liquid. He effects a separation of the two parts of the colloid by filtration through collodion, and analyses each. He thus obtains a limit of washing corresponding to the formula $Fe_2(OH)_{6\cdot\frac{1}{10}}Fe_2Cl_6$.

# MISCELLANEOUS.

**Additional Notes to Mr. F. Soddy's Paper on "The Evolution of the Elements" (Aug. 24).**—At p. 88, col. 2, after line 21, insert—

> "This indicates that thorium is not a member of the uranium-radium series, for in this case there would exist no proportionality between the uranium and radium, although there would be between the thorium and radium."

After line 38, insert—

> "In the subsequent discussion opened by Mr. Strutt on the connection between radium and the internal heat of the earth, the author suggested that Strutt's results seemed to offer the first experimental indication that such a process of atomic upbuilding with absorption of energy was taking place in Nature."

The following corrections should also be made:—P. 85, col. 1, line 23, for "distinctive" read "destructive." Col. 2, line 12, for "ἐν το παν" read "ἐν το παν."

**Attempt on the Life of Prof. Harrison, C.M.G., M.A.**—The news has lately come to hand of an attempt to bar the progress of the practical application of scientific knowledge in such a manner as to call for some comment. A certain section of the Creole inhabitants of Georgetown, British Guiana, have apparently a keen sense of poetic justice, and a firm belief in the efficacy of meeting the devil with his own weapons. So when the Director of the Government Laboratory made inconvenient discoveries relating to the adulteration of foods and the illicit distillation of spirits, they felt that a scientific method of retaliation would meet the case, and proceeded to arrange for the addition of large quantities of arsenic to the supply of drinking-water in the laboratory. The results of this scheme, although no doubt disappointing to its originators, were sufficiently serious. Prof. Harrison, the Director of Science and Agriculture in British Guiana, was rendered dangerously ill, and has had to be invalided home in consequence to recuperate, and no fewer than seven of the assistant analysts and others who drank the water were affected, so that the laboratory actually had to be closed for one day owing to the indisposition of the whole staff. We are glad to take this opportunity of expressing our sympathy with Prof. Harrison, who was the chief sufferer, and the hope that he may soon be completely restored to health. Although in more enlightened countries the methods of disposing of unpopular officials are perhaps a trifle more subtle, instances are not wanting to show that merit and distinction in the scientific world are by no means always recognised at their true value, and there is all the more food for thought in this reflection, because the would-be obstructors of the progress of science are not, as in British Guiana, the uneducated, who regard it merely as providing an arbitrary method of reducing profits, but those to whom the administration and guidance of the affairs of the nations are entrusted.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Vol. XCIV., No. 2441.
(STUDENTS' NUMBER).

# UNIVERSITIES AND COLLEGES.

## UNIVERSITY OF LONDON.

Candidates for any Degree in this University must either have passed the Matriculation Examination in this University, or be admitted under the Statute which provides that the Senate may admit graduates of or persons who have passed the examinations required for a degree in other Universities approved by it. This and all other Examinations of the University, together with the Prizes, Exhibitions, Scholarships, &c., are open to Women upon exactly the same conditions as to Men.

There are three Examinations for Matriculation in each year; commencing on the second Monday in September, January, and June (or July, as may hereafter be determined).

Every candidate entering for the Matriculation Examination must pay a Fee of £2. If a candidate withdraws his name, or fails to present himself at the Examination, or fails to pass it, the Fee shall not be returned to him.

Candidates are not approved by the Examiners unless they have shown a competent knowledge in each of the following five subjects:—(1) English—Composition, Précis Writing, salient facts in English History and Geography. (2) Elementary Mathematics. (3) Latin or Elementary Mechanics, or Elementary Physics—Heat, Light, and Sound, or Elementary Chemistry, or Elementary Botany. (4) and (5) Two of the following subjects, neither of which has already been taken under Section (3). If Latin be not taken, one of the other subjects selected must be another Language from the List, either ancient or modern:—Latin, Greek, French, German, *Arabic, *Sanskrit, *Spanish, *Portuguese, *Italian, *Hebrew, and *Zoology, Ancient History, Modern History, Logic, Physical and General Geography, Geometrical and Mechanical Drawing, Mathematics (more advanced), Elementary Mechanics, Elementary Chemistry, Elementary Physics—Heat, Light, and Sound, Elementary Physics—Electricity and Magnetism, and Botany. Candidates in subjects marked with asterisk must give at least two months' notice before the commencement of the Examination.

A Pass Certificate, signed by the Principal, will be delivered to each successful candidate after the Report of the Examiners has been approved by the Senate.

Several valuable Scholarships and Exhibitions are available to students.

### Intermediate Examination in Science.

The Intermediate Examination in Science will commence on the second Monday in July.

No candidate (with the exception of such as have obtained Honours at the Matriculation Examination in the preceding January) is admitted to this Examination within one academical year of the time of his passing the Matriculation Examination.

The Fee for this Examination is £5.

*Examination for Honours.*

Candidates for Honours in Chemistry will be examined in Inorganic Chemistry, treated more fully than in the Pass Examination. This Examination will consist of two printed papers and a practical examination.

In the Examination for Honours, the Candidate, not being more than 22 years of age at the commencement of the Pass Examination, who most distinguishes himself will receive an Exhibition of £40 per annum for the next two years.

### B.Sc. Examination.

The B.Sc. Examination will be held on the fourth Monday in October.

Candidates for this Examination are required to have passed the Intermediate Examination in Science at least one academical year previously, and to have passed the Matriculation Examination at least three years previously.

The Fee for this Examination is £5.

*Examination for Honours.*

For the examination for Honours in Chemistry candidates are required to show a general acquaintance with General Theoretical Chemistry, Chemistry of Carbon Compounds, Physical Chemistry, and History of Chemistry since the time of Boyle.

The candidate, being not more than 23 years of age, who most distinguishes himself in Chemistry, will receive £50 per annum for the next two years, with the style of University Scholar.

### Doctor of Science.

The examination for the Degree of Doctor of Science takes place annually within the first twenty-one days of June.

No candidate is admitted to the examination for the Degree of D.Sc. until after the expiration of two Academical Years from the time of his obtaining the Degree of B.Sc. in this University.

### Preliminary Scientific (M.B.) Examination.

This Examination takes place twice in each year,—once, for Pass and Honours, commencing on the second Monday in July; and once for Pass Candidates only, commencing on the third Monday in January.

The Fee for this examination is Five Pounds.

## UNIVERSITY OF OXFORD.

*Waynflete Professor of Chemistry*—W. Odling, F.R.S.
*Lees Reader in Chemistry*—G. Brereton Baker, M.A.

Every Student must reside in one or other of the Colleges or Halls, or in licensed lodgings, for a period of three years. Students of Chemistry can obtain the degree of B.A. by passing preliminary examinations in Arts and in Science, and a final Honour examination in Chemistry. Chemistry may also be taken as part of the examination for a Pass degree. Graduates of other Universities suitably qualified can obtain the degree of Bachelor of Science after an approved course of study or research and two years' residence.

*University Laboratory.*—Demonstrators, W. W. Fisher, M.A., J. Watts, M.A., and J. E. Marsh, M.A.—The fee for students working in the Laboratory for three days in the week during the Term is £3; for students working every day, £5.

Scholarships of about the value of £80 are obtainable at the majority of the colleges, by competitive examination in Natural Science.

More detailed information may be obtained from the Examination Statutes; the Student's Handbook to the University; and from the professors and college tutors.

## UNIVERSITY OF CAMBRIDGE.

*Professor of Chemistry*—G. D. Liveing, M.A., F.R.S.
*Jacksonian Professor of Natural and Experimental Philosophy*—Sir James Dewar, M.A., F.R.S.

The Student must enter at one of the Colleges or Hostels, or as a Non-collegiate Student, and keep terms for three years by residence in the University. He must pass the previous examination in Classics and Mathematics, which may be done in any term of residence or before commencing residence. He may then proceed to take a Degree in Arts, either continuing mathematical and classical study, and passing the ordinary examinations for B.A., or going out in one of the Honour Triposes.

A graduate of another University may be admitted as an "advanced" student, and obtain a degree after two years' residence in the University.

The scholarships, ranging in value from £20 to £100 a year, are chiefly given for mathematical and classical proficiency. Scholarships, or Exhibitions, are given for Natural Science at the several Colleges; the dates of the examinations vary, but are always fully advertised.

The Chemical Laboratory of the University is open

daily for the use of the Students. The Demonstrators attend daily to give instruction. A list of the lectures is published annually, in June, in a special number of the *Cambridge University Reporter*, which may be had from the Cambridge Warehouse, in Paternoster Row, or through any bookseller.

Non-collegiate Students are allowed to attend certain of the College Lectures and all the Professors' Lectures, and have the same University status and privileges as the other Students. Full particulars may be obtained by forwarding a stamped directed envelope to the Assistant Registrary, Cambridge, or from the *Cambridge University Calendar*.

## UNIVERSITY OF DUBLIN.

### Trinity College.

*Professor of Chemistry*—Sydney Young, D.Sc., F.R.S.

*Professor of Applied Chemistry*—Emil A. Werner, F.C.S., F.I.C.

*Demonstrator*—W. C. Ramsden, F.C S.

The general Quantitative and Research Laboratories include working accommodation for about 130 Students. The Laboratories will open on October 1st. Lectures will commence about November 1st.

The Laboratories and the Lectures ofthe Professor of Chemistry can be attended by Students who do not desire to reside in the University or proceed to its Degrees.

The full Course of General and Analytical Chemistry occupies three years, but a Student is free in his third year to devote most of his time to a special department of Pure or Technical Chemistry. Students can enter for any portion of the Course. The Lectures delivered are:—

1. *Inorganic Chemistry and Chemical Philosophy.*—Elementary, first year; Advanced. Inorganic Chemistry, second year; Physical Chemistry, third year.
2. *Organic Chemistry.*—General, second year; advanced, third year.
3. *Metallurgy.*—A Course for Engineering and Technical Students.

The Laboratories are open every day from 10 to 5 o'clock (except Saturdays, when they close at 1 o'clock).

*The Summer Course of Practical Chemistry for Medical Students* begins early in April and terminates about the end of June.

A special course for Dental Students will be given.

The University of Dublin grants the Degree of Doctor of Science to graduates of Master's standing whose independent researches in any branch of Science are of sufficient merit.

By recent decrees, Prizes in Chemistry and Physics will be given in future at the October (Arts) Entrance Examination, and also at the Terminal Examinations of the Junior and Senior Freshmen Years.

Similarly, two Science Scholarships will be obtainable by Undergraduates, and tenable for five years. These Foundation Scholars receive £20 per annum, have free commons, their chambers for half the charge paid by other students, and their tutorial fees are at one-fourth the usual rates.

## KING'S COLLEGE.

### (Division of Engineering and Applied Science).

*Professor of Chemistry*—J. M. Thomson, F.R.S., F.C.S.

*Assistant Professor*—Herbert Jackson, F.C.S.

*Lecturer and Demonstrators*—P. H. Kirkaldy, F.C.S., D. Northall Laurie, F.C.S., S. W. Collins, and L Hinkel.

The Academical Year consists of Three terms. The days fixed for the Admission of New Students in the Academical Year 1906-1907 are Oct. 3, Jan. 3, and April 24.

Students of the First Year are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a view of the conditions suitable for the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic Elements and their principal compounds are described. The Metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts; and the processes of the different Manufactures and of Domestic Economy are explained and illustrated. Examinations of the Class, both *vivâ voce* and by written papers, are held at intervals during the course at the usual Lecture hour.

*Second Year.*—Students attend in the Laboratory twice a week, and they go through a course of Chemical Analysis, both by liquid tests and the blowpipe, analysis of ores, liquids, &c., and Elementary Volumetric Analysis.

*Experimental and Analytical Chemistry in the Laboratory.*—The object of this Class is to afford to Students who are desirous of acquiring a knowledge of analysis, or of prosecuting original research, an opportunity of doing so under the superintendence of the Professor and Demonstrator; Students may enter, upon payment of extra fees, at any time except during the vacation, and for a period of one, three, six, or nine months, as may best suit their convenience. The laboratory hours are from ten till four daily, except Saturday.

In addition to the Laboratory Fee, each Student defrays the expenses of his own experiments. The amount of this expense, which is comparatively trifling, is entirely under his own control.

Special hours and fees are arranged for the convenience of such Third Year Students as wish to study Analytical Chemistry.

Fees.—Chemistry: Winter Session, £5 5s.; Summer Session, £3 3s. Practical Chemistry: Winter Session, £8 8s.; Summer Session, £4 4s. Experimental and Analytical Chemistry—Five days a week: One month, £4 4s.; One Term, £10 10s.; Two Terms, £18 18s.; Three Terms, £26 5s. Three days a week: One month, £2 12s. 6d.; One Term, £6 6s.; Two Terms, £11 11s.; Three Terms, £15 15s.

### Metallurgy.

*Professor*—A. K. Huntington, A.R.S.M , F.I.C., &c.

The following subjects are treated of in the Lectures: The Selection and Economic Preparation of Fuel and of Refractory Materials; the methods by which metals are obtained from their ores, and the means by which they are rendered suitable for the various requirements of the Arts.

Particular attention is paid to the study of the Nature and Properties of Metals and Alloys available for Constructive Purposes.

In the Metallurgical Laboratory, which is always open during College hours, the relation between the Chemical Composition of Metals and their Mechanical Properties may be studied by the aid of Testing Machinery.

Fee, £3 3s. for the Course.

### Photography.

*Lecturer*—Prof. J. M. Thomson, F.R.S., F.C.S.

For particulars apply to Prof. Thomson.

### Evening Classes.

Classes for Evening Instruction in various subjects are held during the Winter Session.

## UNIVERSITY COLLEGE.

### Faculty of Science.

*Professors*—Sir William Ramsay, K.C.B., LL.D., F.R.S. (Inorganic and Physical Chemistry); J. Norman Collie, Ph.D., F.R.S. (Organic Chemistry).

*Assistants*—E. C. C. Baly, F.I.C.; J. K. H. Inglis, D.Sc., M.A.; N. T. M. Wilsmore, M.Sc.; and S. Smiles. D.Sc.

The Session is divided into three Terms, as follows:—First Term, from October 3 to December 21; Second Term, from January 15 to March 27; Third Term, from April 23 to July 8.

*Introductory Course of Inorganic Chemistry.*

Tuesday and Thursday, at 9. Practical, Friday, 2 to 3.30, or 3.30 to 5. Fee, £10 10s.

This Course treats of the chief physical and chemical characters of the Non-metallic Elements, their preparation and characteristic tests.

*Junior Course of Inorganic Chemistry.*

First and Second Terms: The Class meets four times a

week, on Mondays, Wednesdays, Fridays, and Saturdays, at 9, for Lectures, Examinations, and Exercises.

In this Course the physical principles bearing on Chemistry are first discussed, and the Chemistry of the Elements and their compounds is treated in considerable detail, under the headings—Elements; hydrides, halides, oxides, sulphides, &c., borides, carbides and silicides, nitrides, phosphides, &c., and alloys. Special attention is devoted to substances of commercial importance. The concluding Lectures are devoted to Physical Methods and their bearing on Chemical Problems.

Third Term: Lectures will be given on Mondays and Fridays at 9 and on Wednesdays at 11, on the chief types of Carbon Compounds.

Fees: Course, £7 7s.; First or Second Terms, £4 4s.

A Practical Class will meet throughout the Session.

*Course of Physical Chemistry.*

October to February: Tuesday and Thursday at 9. February to June: Monday and Saturday at 9.

The Principles of Chemistry will be specially considered, comprising the Atomic Theory, Chemical Classification, the Periodic Law, Thermal Chemistry, Dissociation, the Application of Physical Methods to the Solution of Chemical Problems, and the influence of Mass and Temperature on the progress of Reactions. Special attention is paid to the most recent Chemical Theory researches.

Fees:—Courses, £5 5s.; Term, £2 2s.; for a second course, £1 1s.

*Senior Course of Inorganic Chemistry.*

This Course will begin about the middle of February; Tuesday and Thursday at 9. Fee, £3 3s.

*Electro-chemistry.*

First Term, Monday and Saturday at 9; Second Term, Wednesday and Friday at 12. Fee, £2 2s.

*Organic Chemistry.*

Mon. at 12, Wed. and Fri. at 9, during the session.

This Course is suitable for Students who intend to study Chemistry from a scientific standpoint. No previous knowledge of Organic Chemistry is expected of those attending the Class, which should, however, be taken concurrently with the Course of Physical Chemistry, and with Practical Organic Chemistry in the Laboratory.

Fee:—For the Course, £6 6s.; for a Term, £2 12s. 6d.] for a Second Course, £3 3s.

An Advanced Course will be held twice a week throughout the Session for those engaged in prosecuting research in Organic Chemistry. Fee, £5 5s.; Term, £2 2s.

*Practical Classes.*

Practical Classes in Inorganic and Organic Chemistry are conducted by the Assistants.

*Analytical and Practical Chemistry.*

The Laboratories are open daily from 9 a.m. to 5 p.m., Saturdays excepted, from October until the middle of July, with a short recess at Christmas and at Easter.

Fees: for the Session, £26 5s.; six months, £18 18s.; three months, £10 10s.; one month, £4 4s.

Three specified days a week:—for the Session, £15 15s.; six months, £11 11s.; three months, £6 6s.; one month, £2 12s. 6d., exclusive of expense of materials. Students may enter at any period of the Session.

When accompanied by, or preceded by, attendance on the Lectures on Inorganic and Organic Chemistry, the Laboratory Courses qualify Students in the application of Chemistry to Manufactures, Metallurgy, Medicine, or Agriculture, &c.

There is also a Chemical Library containing the chief Journals and Standard Works on Chemistry.

Certificates of Honour are granted to competent Students on the work done during the Session. Several valuable Scholarships are available to students.

## ROYAL COLLEGE OF SCIENCE AND ROYAL SCHOOL OF MINES.

*Professor of Chemistry*—W. A. Tilden, D.Sc., F.R.S.

*Assistant Professor*—M. O. Forster, Ph.D., D.Sc.

*Demonstrators*—H. Chapman Jones; G. T. Morgan, D.Sc., A.R.C.S.; and J. C. Philip, M.A., Ph.D., B.Sc.

*Assistants*—G. S. Newth and Miss Whiteley, D.Sc., A.R.C.S.

The Royal College of Science at South Kensington is intended, primarily, for the instruction of teachers, and of students of the industrial classes selected by competition in the examinations of the Board of Education. The Royal School of Mines is incorporated with the Royal College of Science. Students entering for the Associateship of the Royal School of Mines obtain their general scientific training in the Royal College of Science. The instruction in the Royal College of Science is arranged in such a manner as to give the Students a thorough training in the general principles of Science, followed by advanced instruction in one or more special branches of Science. The Associateship is granted in certain divisions or lines of study. Students who go through any one of the prescribed courses of instruction and pass the necessary Examinations receive a Certificate of Associateship of the Royal College of Science, or of the Royal School of Mines. Students who are not candidates for the Associateship are permitted to enter as occasional students in one or more special branches of science. The Associateship of the Royal College of Science is given in one or more of the following divisions:—Mechanics, Physics, Chemistry, Biology, and Geology, and the Associateship of the Royal School of Mines in Metallurgy and Mining.

The course of instruction lasts for three years, is the same for all the divisions during the first year, after which it is specialised according to the particular division in which the student is working for the Associateship.

Examinations are held at the end of each course of instruction and at such other periods as may be found necessary. On the results of these examinations the successful candidates are arranged in two classes, first and second. There are also "Honours" examinations for the subjects of the third year, the successful candidates being placed in order of merit. A student obtains the Associateship who passes in all the subjects of the first year, and, in the second and third year, those subjects prescribed as necessary for the division in which he seeks to obtain his Associateship. A student who goes through the prescribed course of instruction in any subject except Mining and Metallurgy and passes the necessary examinations receives a certificate to that effect.

Students who do not wish to attend the lectures are admitted for short periods to the laboratories, at the discretion of the Professors. The fees for the laboratories are £4 per month.

Students not entering for the Associateship are admitted to any particular course of study, so far as there is room, on payment of the fees shown in the following table:—

| | Lectures. | Laboratory. |
|---|---|---|
| | £ | £ |
| Chemistry .. .. .. .. | 3 | 13 |
| Physics .. .. .. .. .. | 5 | 12 |
| Biology with Botany .. .. | 5 | 12 |
| Geology with Mineralogy .. | 4 | 8 |
| Mechanics . .. .. .. .. | 4 | 6 |
| Metallurgy .. .. .. .. | 2 | 13 |
| Mining .. .. .. .. .. | 4 | |

The fee for the course of Mine Surveying is £10.

The fees for the first two years amount to about £75, and for the remainder of the course for the Associateship they vary from £30 to £40.

The Session is divided into two Terms. The first Term begins about the first week of October, and ends about the middle of February. The second Term begins in the middle of February, and ends about the middle of June.

The hours of study are from 10 a.m. to 1.15, and from 2 to 4 or 5 p.m. every day, except on Wednesday and Saturday, when the College closes at 1 p.m.

Several valuable Exhibitions, Scholarships, and Prizes are attached to the studentship.

*Summer Courses for Teachers.*—Short courses of in-

struction are given annually, about July, in different branches of science for the benefit of teachers of science schools in the country. The courses last three weeks. About 250 teachers are admitted to them, and they receive third class railway fare to and from South Kensington, and a sum not exceeding £3 towards their expenses.

## THE SCHOOL OF PHARMACY OF THE PHARMACEUTICAL SOCIETY OF GREAT BRITAIN.

The Sixty-fifth Session will commence on Oct. 1, 1906.

*Professors*—Chemistry, Arthur W. Crossley, D.Sc., Ph.D., F.I.C. (Dean); Botany, J. Reynolds Green, Sc.D., F.R.S., F.L.S.; Pharmaceutics, Henry G. Greenish, F.I.C., F.L.S.

A Course of Lectures on Physical, Inorganic, and Elementary Organic Chemistry commences in October and terminates at the end of June. An Advanced Course of Lectures begins in October and extends to the end of March. These Lectures are adapted to the requirements of Pharmaceutical and Medical Students, and also of those who are proceeding to degrees at the University of London, or who are preparing for the examinations of the Institute of Chemistry.

Entries may be made for single classes. Certificates of attendance at the two Courses of Lectures on Chemistry and at the Chemical Laboratories are accepted as evidence of chemical training by the Institute of Chemistry in connection with the Examinations for the Associateship, and also by the conjoint Board of the Royal Colleges of Physicians and Surgeons, as well as by other examining bodies.

Prospectuses and further information may be obtained from the Dean of the School, 17, Bloomsbury Square, London, W.C.

## UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH.

UNIVERSITY OF WALES.

*Professor*—J. J. Sudborough, D.Sc. (Lond.), Ph.D. (Heidelberg), F.I.C.

*Assistant Lecturers and Demonstrators*—A. Brooke, Ph.D. (Strass.), and T. C. James, M.A. (Cantab.), B.Sc.

*Lecturer in Agricultural Chemistry*—J. Alan Murray, B.Sc. (Edin.).

*Lecturer on Dyeing*—(Vacant).

The College is open to male and female students above the age of sixteen years. The Session commences on Oct. 2nd, on which day all Students will be expected to meet the Professors in the Examination Hall of the College.

*Lecture Courses.*—(1) Intermediate Science Course; four lectures weekly throughout the Session. (2 and 3) B.Sc. Courses; A, three lectures weekly on Organic Chemistry; B, three lectures weekly on General and Physical Chemistry. (Courses A and B will generally be given in alternate Sessions; for 1906-1907, Course B). (4 and 5) Courses in Agricultural Chemistry. For students in their first year, 3 lectures, and for those in their 2nd year, 2 lectures weekly during the Michaelmas and Lent terms.

*Laboratory Courses.*—The Laboratories are open daily from 9 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays. Regular Courses of practical work, suitable for the B.Sc. degree of the Universities of London and Wales, or for the Associateship of the Institute of Chemistry, can be followed. Facilities are given for Students wishing to undertake research work. Special Courses will be arranged for those who intend to follow Medicine or Pharmacy, or any one particular branch of Applied Chemistry, always provided that such Students possess the requisite knowledge of Theoretical Chemistry. The hours will be arranged, as far as possible, to suit the requirements of the individual Student.

The College is recognised by the University of Edinburgh and the Royal University of Ireland, and by the Colleges of Physicians and Surgeons of England, Scotland, and Ireland as an institution at which the instruction necessary for their respective Diplomas in Medicine, in Chemistry, Physics, and Biology may be given. One year for graduation in Medicine and two years for graduation in Science may be spent at Aberystwyth.

*Fees.*—The Fee for the whole Session, if paid in advance, is £10; if paid by Single Terms, for the first term of attendance in each Session, £4; for the second term, £3 10s.; for the third term, £3. These composition fees enable the Student to attend any or all the Classes of the College, with the exception that a small extra fee is charged for Laboratory Instruction. Thus, for Practical Chemistry, the additional fee is, for six hours' work per week, 12s. 6d. per term, and for twelve hours, 25s. per term. The fees for those who desire to spend several days weekly in the laboratory may be learned on application to the Registrar. Fee for a single Lecture Course £1 per term.

*Scholarships and Exhibitions* varying in value from £10 to £40 per annum will be offered for competition at examinations which commence on September 18, and exhibitions are awarded at the end of the Session on the results of the class examinations.

Intending Students requiring further information are recommended to write to the Registrar for a copy either of the General Prospectus or of one of the Special Prospectuses issued for the Agricultural and Normal Departments.

## UNIVERSITY COLLEGE OF NORTH WALES, BANGOR.

A CONSTITUENT COLLEGE OF THE UNIVERSITY OF WALES.

*Chemistry.*—Professor, K. J. P. Orton, M.A., Ph.D., F.I.C. Assistant Lecturer and Demonstrator, Alice E. Smith, B.Sc. Assistant Lecturer in Agricultural Chemistry, Alan Baguley, B.Sc., F.I.C. Junior Demonstrator, J. O. Hughes, B.Sc.

*Physics.*—Professor, E. Taylor Jones, D.Sc.

The Session opens October 4th, 1906. All regular classes are open to men and women students above the age of 16 years. The following Courses of Lectures will be given.

*Matriculation Course.*—Subjects: Those prescribed for the Matriculation Examination of the University of Wales. Fee for the Session £3 3s.

*Intermediate Course.*—Inorganic Chemistry and Elementary Physical Chemistry. Fee for the Session, £3 13s. 6d.

*B.Sc. Course.*—Inorganic and Physical Chemistry. Fee for the Session, £3 3s.

*Agricultural Chemistry.*—Fee, £2 2s.

*Laboratory Courses.*—The laboratory is open on five days of the week from 10 a.m. to 5 p.m. for instruction in Chemical Analysis and in the Application of Chemistry to Medicine and the Industrial Arts. Fees: six hours per week, £1 1s. per Term; twelve hours, £2 2s.; eighteen hours, £3 3s.; twenty-four hours, £4 4s. Composition Fee for all Laboratory Classes of the Intermediate Science Course taken in one year, £4 4s.

The Chemistry, Botany, Zoology, and Physics Courses are recognised for Medical graduation in the Universities of Edinburgh and Glasgow, and students can make one *Annus medicus* at the college. Students are prepared for the First Examination of the Conjoint Board of the Royal Colleges of Surgeons and Physicians. The Science Courses are recognised for part of the science degree course of the University of Edinburgh.

## UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE, CARDIFF.

*Professor*—C. M. Thompson, M.A., D.Sc., F.C.S.

*Assistant Professor*—E. P. Perman, D.Sc., F.C.S.

*Demonstrator*—R. D. Abell, D.Sc.

*Lecturer in Metallurgy*—A. A. Read, F.I.C., F.C.S.

The Session commences October 9th, and terminates on June 28th, and is divided into three terms.

The Junior Course (delivered during the Michaelmas term only) consists of about 50 lectures, and will cover the subjects prescribed for the Matriculation examinations of the University of Wales and the University of London. Fee, £2 2s. A revision class is held in the Summer term.

The Intermediate Course consists of about 80 lectures held during the Lent and Summer terms in continuation of the Junior Course; together with laboratory practice it forms the qualifying course for the Intermediate Examination of the University of Wales, and will cover the subjects required for the Intermediate Examination in Science of the University of London. Fee, £4 4s.

The Senior Course consists of about 60 lectures on Inorganic Chemistry; Fee, £3 3s.

A short course on Organic Chemistry will also be given.

The following lectures on Metallurgy will be given by Mr. Read:—10 lectures on Fuel; Fee, 10s. 6d. 20 lectures on General Metallurgy; Fee, £1 1s. 30 lectures on the Manufacture of Iron and Steel; Fee, £1 1s. A practical course on Iron and Steel Analysis will also be held, and practical instruction in Dry Assaying will be given in the Metallurgical Laboratory, which is fitted with the necessary furnaces and apparatus.

In the laboratory each student works independently, so that the course of study may be adapted to the requirements of the individual. Hours, 9 to 1 and 2 to 5; Saturday, 9 to 1. Fees—Six hours per week, £2 2s. per term; twelve hours, £3 3s. per term; eighteen or more hours, £4 4s. per term.

Registered medical students can prepare for the Intermediate M.B. Examination of the University of London, and spend three out of their five years of medical study in Cardiff. Medical students wishing to graduate at a Scottish University, or preparing for a Conjoint Board Surgical and Medical Diploma, or for the Diploma of the Society of Apothecaries, can spend two years in Cardiff. For further information see the prospectus of the Faculty of Medicine, which may be obtained from the Registrar.

The College is recognised as an institution at which two years of the course for the degree of Bachelor of Science of the University of Edinburgh may be spent.

Students by making a payment of £10 at the commencement of each session may compound for all lecture fees for the whole session. Laboratory fees are not included in the composition fee, but Students preparing for the Science Examinations of the University of Wales and of the University of London may, by making a payment of £13 13s. at the commencement of each Session, compound for both Lecture and Laboratory Fees during the Session.

At the entrance examination in September, and the annual examination in June, several scholarships and exhibitions are awarded. Great importance is attached to special excellence in one subject.

The College Prospectus, and also further information as to scholarships, may be obtained from the Registrar.

A Hall of Residence for Women Students is attached to the College.

## UNIVERSITY COLLEGE, BRISTOL.

*Professor of Chemistry*—Morris W. Travers, D.Sc., F.R.S.

*Assistant Professor*—Francis Francis, D.Sc., Ph.D., F.I.C.

*Lecturer*—Oliver C. M. Davis, B.Sc., A.I.C.

*Lecture Assistant*—J. H. Sturgess.

The session 1906-1907 will begin on October 2. Lectures and classes are held every day and evening throughout the Session. In the Chemical Department lectures and classes are given in all branches of theoretical chemistry, and instruction in practical chemistry is given daily in the chemical laboratory. The department of experimental physics includes various courses of lectures arranged progressively, and practical instruction is given in the physical and electrical laboratories. The Department of Engineering and the Constructive Professions is designed to afford a thorough scientific education to students intending to become engineers, or to enter any of the allied professions, and to supplement the ordinary professional training by systematic technical teaching. This department includes courses specially arranged for students intending to become civil, mechanical, electrical, or mining engineers, surveyors, or architects. Those who attend the mechanical engineering course enter engineering works during the six summer months, and, in accordance with this scheme, various manufacturing engineers in the neighbourhood have consented to receive students of the College into their offices and workshops as articled pupils at reduced terms. Medical education is provided by the Faculty of Medicine of the College. Several Scholarships are tenable at the College. Full information may be obtained from the Registrar.

### Day Lectures.

*Inorganic Chemistry.*

The Courses treat of the principles of Chemistry, and of the Chemistry of the Non-Metals and Metals.

*Elementary Course.*—Three Lectures a week will be given during the Session. Fee, £3 13s. 6d.

*Special Course.*—A special course of Lectures is also given to Elementary Teachers.

*General Course.*—Four Lectures a week will be given throughout the Session. Fee, £3 13s. 6d.

*Advanced Course.*—Two Lectures a week will be given throughout the Session. Fee, £3 13s. 6d.

*Organic Chemistry.*

*General Course*—Three Lectures a week will be given throughout the Session. Fee, £3 13s. 6d. An advanced course of lectures will also be given one day a week during the session. Fee, £2 2s.

*Practical Chemistry.—Laboratory Instruction.*

The Chemical and Metallurgical Laboratories will be open daily from 9 a.m. to 5 p.m., except on Saturdays, when it will be closed. Instruction will be given in the Laboratory in all branches of Practical Chemistry, including Qualitative and Quantitative Inorganic and Organic Analysis, the preparation of Chemical Products, Metallurgy, and Inorganic and Organic Research. Special facilities will be afforded to those who desire to study Practical Chemistry as applied to the different processes employed in the Arts and Manufactures. Fees in Guineas—

| Days per Week .. | Five. | Four. | Three. | Two. | One. |
|---|---|---|---|---|---|
| Per Session .. .. | 15 | 12½ | 10 | 7½ | 5 |
| „ Two Terms .. | 11 | 9 | 7½ | 5½ | 3½ |
| „ One Term .. | 7 | 6 | 4½ | 3½ | 2½ |

Students may arrange to divide their days of laboratory work into half-days.

*Chemical Scholarship.*—Among others, a Chemical and a Metallurgical Scholarship each of £25 are offered for competition.

### Evening Lectures.

A course of Lectures, which is subject to variation to suit the requirements of Students, will be delivered during the Session. Fee, 10s.

*Pharmaceutics.*—During the second and third Terms a course of Lectures will be given one evening a week dealing with the recent advances in Chemistry. Fee, 5s.

*Practical Chemistry—Laboratory Instruction.*—The Laboratory will be open one evening a week from 6 till 9. Instruction will be given in Qualitative and Quantitative Analysis, and in the Preparation of Chemical Products. Fees:—Two Terms, 21s; One Term, 12s. 6d.

University College, Bristol, has been approved by the Council of the Institute of Chemistry as a College at which all the subjects required for the admission of Associates to the Institute are taught.

The Calendar of the College, price 1s. (post-free, 1s. 4d.), containing detailed information of the various Courses, may be obtained on application to the Registrar.

## MERCHANT VENTURERS' TECHNICAL COLLEGE, BRISTOL.

### Chemistry and Metallurgy.

*Professor*—J. Wertheimer, B.Sc., B.A., F.I.C., F.C.S.

*Assistant Professor*—G. P. Darnell Smith, B.Sc., F.I.C., F.C.S.

*Lecturers*—H. A. M. Borland, A.R.C.S.; E E. Elt, B.Sc.

*Demonstrators*—E. H. T. Parker; P. W. Alloway; C. D. Fuller.

*Assistants in Chemical Laboratory*—W. F. Phillips and C. Cox.

The Laboratories of this Department are open during the Term on every week-day as a School of Practical Chemistry, Analysis, and Assaying, to Students of either sex. They include the Junior Laboratory (for forty Students working at one time), Senior Laboratory, Balance Room, Combustion Room, Store Rooms, Metallurgical Laboratory, and Research Laboratory. Each Student works independently, and receives individual instruction and help.

The training in this Department is intended to fit Students to become Professional Chemists, to prepare them for Medical or Pharmaceutical examinations in Chemistry, to instruct them in the branches of Applied Chemistry required in Manufactures and Agriculture, and to train them in practical Metallurgical processes, especially Assaying.

Special facilities will be given to Students wishing to undertake research work approved by the Professor; and the Courses provide for the Examinations in Chemistry for the B.Sc., M.B., and D.Sc. degrees of the University of London.

The three years' course at this College in the subjects of Theoretical and Practical Chemistry, Theoretical and Practical Physics, and Elementary Mathematics, is accepted by the Council of the Institute of Chemistry as satisfactory evidence of the training of candidates for the Associateship of the Institute.

Certificates of Proficiency in Assaying will be given to Students who complete a Course of not less than two years' work in the Metallurgical Department, and pass satisfactorily the College examinations in the Theory and Practice of Assaying.

The Laboratories are open every week-day from 9 till 12 noon, and from 1.30 to 4 30 p.m., except Saturday, when they close at noon.

The Annual Fee of £10 10s. secures (in addition to the use of either or both Laboratories) permission to attend the Lectures in Physics and Mathematics as well as Chemistry, and to use the Physical Laboratory and the Engineering Workshop.

The College Day Classes re-open on Sept. 18, and the Evening Classes commence on Monday, October 1.

Further detailed information may be obtained from the College Calendar, price 6d., or the Prospectus for Day or Evening Classes (free).

## UNIVERSITY OF BIRMINGHAM.

*Professor*—Percy F. Frankland, Ph.D., M.Sc., LL.D., F.R.S., P.I.C.

*Assistant Lecturers and Demonstrators*—Alex. Findlay, M.A., D.Sc., Ph.D.; Hamilton McCombie, M.A , Ph.D., B.Sc., A.R.C.S., A.I.C.; C. K. Tinkler, B.Sc., and T. J. Murray, Ph.D.

The Session will be opened on October 1st, 1906.

### *Lecture Courses.*

*First Year.*—A. This part of the course is arranged (1) to give a full exposition of the general principles of Chemical Science, (2) for the systematic study of the properties of the more important elements and their compounds, and (3) to indicate the chief applications of Chemistry in the Arts and Manufactures. Four hours weekly during the Winter and Spring terms. Mondays to Thursdays inclusive, at 9.30 to 10.30 a m. Fee, £5 5s. B. This part of the course includes an introduction to the study of Organic Chemistry, with a description of the properties, relations, and methods of preparation of the more important groups of Carbon Compounds. Three hours weekly during the Summer term. Mondays, Wednesdays, and Fridays, at 9.30 to 10 30 a.m. Fee, £1 11s. 6d.

*Second Year.—Advanced Organic Chemistry.*—This course extends over two years, and is divided into two parts:—(*a*) Carbon Compounds of the Fatty Series; (*b*) Aromatic and other Cyclic Compounds. Only one of these parts will be taken in each year. The class meets twice weekly by arrangement during the Winter and Spring terms. Fee, £2 2s. *General and Physical Chemistry.*—This course will deal in outline with the more recent developments of Theoretical Chemistry. The class meets once weekly by arrangement during the three terms. Fee, £1 11s. 6d.

*Third Year.*—A further Course in Advanced Organic Chemistry will deal with one of the above parts of the Course. The class meets two hours weekly by arrangement during the Winter and Spring terms. Fee, £2 2s. A further Course on General and Physical Chemistry, in which special subjects attracting attention at the time receive treatment. Fee, £1 11s. 6d.

### *Practical Chemistry.*

The instruction in Practical Chemistry extends over three years. The Laboratory will be open daily from 9 30 to 5, except Saturdays, when it closes at 1 p.m. Fees—

| | All day. | Three hours per day. | Three hours per day; five days a week. | Three hours per day; three days a week. |
|---|---|---|---|---|
| | Guineas. | Guineas. | Guineas. | Guineas. |
| One Term .. | 7 | 4½ | 4 | 2½ |
| Two Terms . | 13 | 8½ | 7½ | 5 |
| Three Terms | 18 | 12 | 11 | 6½ |

A Course of short demonstrations and exercises is given by the Professor or one of his Assistants once a week. All first-year Students are required to attend, unless exempted for special reasons by the Professor. No Fee.

Special facilities are given to Advanced Students for the prosecution of original research.

### *Metallurgy.*

There is a separate University department for Metallurgical students in which provision is made for instruction in assaying, &c.

### *Scholarships.*

*Priestley Scholarships.*—Three Open Scholarships in Chemistry of the value of about £96 each are awarded annually in June.

*Ascough Scholarship.*—One Open Scholarship of the value of about £30 is awarded annually in July.

*Bowen Scholarship.*—One Open Scholarship in Metallurgy, value about £96, is awarded annually in June.

For particulars apply to the Registrar.

### *Excursions.*

During previous Sessions permission has been obtained to visit some of the great factories in or near Birmingham, in which chemical and metallurgical industries are carried on. Students have thus had most valuable opportunities of gaining a practical acquaintance with some branches of Applied Science. The privilege thus courteously granted by several manufacturers will, it is hoped, be enjoyed in every future Session. The excursions will be conducted by the Professor or Lecturers.

## CITY OF BRADFORD TECHNICAL COLLEGE.

### Department of Chemistry and Dyeing.

*Head of Department*—Prof. W. M. Gardner, M.Sc.

*Lecturers in Chemistry*—B. North, A.R.C.Sc. (Lond.) L. L. Lloyd, Ph.D.; S. F. Stell, F.C.S.

*Demonstrator in Chemistry*—S. R. Illingworth.

*Lecturer in Physics*—J. A. Tomkins, A.R.C.Sc. (Lond.).

*Demonstrator in Physics*—E. B. Walker.

*Lecturers in Dyeing*—A. Herz, Ph.D., and A. B. Knaggs, F.C.S.

*Demonstrator in Dyeing*—L. Minikin.

*Lecturer in Gas Manufacture*—W. Cranfield,

*Lecturer on Botany, Biology, and Pharmacy*—W. West, F.L.S., Ex. Pres. Yorkshire Naturalists' Union.

The following courses of instruction are provided:—

I. *General Chemistry Course*, extending over four years, including Lectures in Inorganic, Organic, and Technological Chemistry, Principles of Analysis, Technical Analysis, Electro-chemistry, Physical Chemistry, Crystallography, Fuels, Lighting and Ventilation, Physics, Mathematics, Mechanics, with Laboratory work in Chemistry, Physics, Bacteriology, and Microscopy.

II. *Chemistry and Dyeing*, extending over four years. Includes most of the above subjects, along with Lectures and practical work in Dyeing, Colour matching, &c.

III. *Chemical Engineering*. Three years' course, preparing Students for positions in Chemical Works, Sewage Works, &c.

IV. *Sanitary Science*. One year's Course, recognised by the Sanitary Institute as preparing for their certificate examination. Subjects: Chemistry, Physics, Sanitary Engineering, Sanitary Law, Building Construction, Drawing, Physiology, and Bacteriology.

V. *Dyeing*. Extending over one or two years.

VI. *Textile and Dyeing*. Arranged for those Students who desire to study the two subjects simultaneously.

VII. *First Professional Examination, Conjoint Medical Board (M.R.C.S., L.R.C.P.), London*.—Attendance at the College and College Certificates in Chemistry, Physics, and Biology are recognised by the Conjoint Board for Medical Studies as a qualifying curriculum.

VIII. *General Pharmaceutical Course*. Prepares for the Minor and Major Pharmaceutical Examinations. Each extends over two years on three half-days per week, and includes Chemistry and Physics, Botany, Biology, Materia Medica, Pharmacy, and Dispensing.

## ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.

### Chemical Department.

*Professor*—Prof. E. Kinch, F.C.S., F.I.C.

*Assistant*—W. James.

Systematic courses of Lectures are given on the various branches of Chemistry in its relation to Agriculture, illustrated by experiments, and by the collections in the College Museum. They comprise the laws of Chemical Combination and the general Chemistry of mineral bodies, and of the more frequently occurring bodies of organic origin, with the relationships of their leading groups; and, finally, the applications to practical operations of the Chemistry of the atmosphere, of soils and manures, of vegetation, of stock feeding, and of the processes and products of the dairy.

In the Laboratory practical instruction is given in the construction and use of apparatus and in Chemical manipulation and analysis, both qualitative and quantitative. After studying the simple operations and the properties of the commonly occurring substances, the Students are taught to analyse a series of compounds, and apply the knowledge thus obtained to the analysis of manures, soils, waters, feeding stuffs, dairy products, and other substances met with in the ordinary course of Agricultural practice. Chemico-agricultural researches are undertaken by the senior Students under the direction of the Professor and his Assistants.

## THE UNIVERSITY OF LEEDS.

*Professor of Chemistry*—Arthur Smithells, B.Sc., F.R.S.

*Professor of Organic Chemistry*—Julius B. Cohen, Ph.D., B.Sc.

*Lecturer on Physical Chemistry*—H. M. Dawson, B.Sc., Ph.D.

*Assistant Lecturers and Demonstrators*—C. E. Whiteley, M.Sc., and W. Lowson, B.Sc., F.I.C.

*Demonstrator*—W. H. Perkins, B.Sc.

The Session begins October 1, 1906.

### *Lecture Courses.*

1. General Course of Chemistry.—Monday, Wednesday, and Friday, at 11.30 a.m. Fee for the Course, £4 4s.

2. Advanced Inorganic Chemistry.—Metals. Monday, Wednesday, and Friday, at 9.30 a.m. Fee, £3 13s. 6d.

3. Advanced Inorganic Chemistry.—Non-metals. Tuesday, Thursday, and Saturday, at 9.30 a.m. Fee, £3 13s. 6d.

4. Organic Chemistry. — Tuesday, Thursday, and Saturday at 12 noon Fee £3 13s. 6d.

5. Honours Courses —(*a*) Organic Chemistry: Monday, Wednesday, and Friday at 12 noon in the First and Second Terms; fee, £2 12s. 6d. (*b*) History of Chemistry: Monday, Wednesday, and Friday at 9.30 a.m. in the First Term; fee, £1 11s. 6d. (*c*) Physical Chemistry: Monday, Wednesday, and Friday at 9.30 a.m. in the Second and Third Terms; fee, £2 12s. 6d. (*d*) Electro-chemistry: One hour weekly; 31s. 6d.

6. Chemistry of Food and Drugs.—Special class for Students taking Final Examination of the Institute of Chemistry in Branch E (Food and Drugs). £2 2s.

### *Laboratory Courses.*

The University Laboratory will be open daily from 9 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it will close at 1 p.m.

Fees for the Session—Students working six days per week, £21; five, £18 18s.; four, £16 16s.; three, £13 13s.

*Practical Course in Sanitary Chemistry*.—Tuesdays and Thursdays from 2 to 5 from April to June. Fee, £5 5s.

*Elementary Science for Teachers*.—Saturdays, 9.30 to 12.30, for half the session. £2 12s. 6d.

### *Dyeing and Tinctorial Chemistry Department.*

*Professor*—Arthur G. Green, M.Sc., F.I.C.

*Lecturer and Research Assistant* — A. G. Perkin, F.R.S., F.I.C.

*Assistant Lecturer*—A. B. Steven, B Sc.

The Courses extend over periods of three or four years, and are intended for those who wish to obtain a full scientific and practical education in the art of dyeing, &c. It is suitable for those who purpose in the future to take any part in the direction of the operations of dyeing or printing of textile fabrics, *e.g.*, the sons of manufacturers, calico printers, managers, master dyers, &c.

### *Leather Industries Department.*

*Professor*—H. R. Procter, M.Sc., F.I.C.

*Assistant Lecturer and Demonstrator*—F. Kopecky.

*Demonstrator*—Harold Brumwell.

The full Courses, which extend over a period of either two or three years, are suitable to all who intend to become Technical Chemists in the Leather Industry, or managers of important works, and are recommended to sons of tanners. The Courses include instruction in chemistry, a modern language, leather manufacture, and practical work in the Leather Industries Laboratory and Dye-house.

### *Agricultural Department.*

*Professor*—R. S. Seton, B.Sc.

*Lecturer in Agricultural Chemistry*—C. Crowther, M.A., Ph.D.

The full Course occupies two years, and includes instruction in chemistry, physics, mathematics, geology, botany, forestry, engineering and surveying, and the principles of agriculture, as well as practical work in the various laboratories and out-door agriculture.

Research Students are admitted to the University Laboratories on reduced terms.

Several valuable Fellowships and Scholarships are at the disposal of the University, viz., the Salt, Akroyd, Brown, Baines, Emsley, Craven, Wheatley, Leeds City Council, and Clothworkers' Scholarships, and one of the 1851 Exhibition Scholarships. The North, East, and West Ridings County Council's Scholarships are tenable at the University of Leeds.

## UNIVERSITY OF LIVERPOOL.

*Professor of Chemistry*—J. Campbell Brown, D.Sc.

*Professor of Physical Chemistry*—F. G. Donnan, M.A., Ph.D.

*Lecturer on Organic Chemistry*—A. W. Titherley, D.Sc., Ph.D.

*Lecturer on Metallurgy*—Guy D. Ricketts, M.A.

*Demonstrators and Assistant Lecturers*—A. T. de Mouilpied, M.Sc., Ph.D.; H. Bassett, B.Sc., Ph.D., D.es.Sc.; F. J. Brislee, D.Sc.; J. McConnan, M.Sc., Ph.D.; A. Rule, M.Sc., Ph.D.; and E. Garratt, M.Sc.

*Assistant*—H. H. Froysell.

The Session commences October 9th.

Entrance Scholarship Examination takes place early in May each year.

The Classes meet the requirements of candidates for the Ordinary B.Sc. Degree, for Chemistry Honours, or for the M.Sc. or D.Sc. Degree in the University of Liverpool; for Degrees in Medicine of Liverpool; for the Pharmaceutical, Veterinary, Dental, and Public Health Diplomas; and for those studying Chemistry as a preparation for professional, technical, or commercial life. The Classes qualify for the Fellowship of the Institute of Chemistry and other Examination Boards.

*Lecture Courses.*

A. General Course on the principal non-metallic elements and the most important metals, the principles of Chemical Philosophy, and an introductory sketch of Organic Chemistry. Three Terms. Fee, £4.

Engineer's Course of Lectures with Practical Class. Two Terms. Fee, including Practical class, £3.

Pharmacy Courses: Junior, £3; Senior, £3.

Course B.—Inorganic Chemistry. Fee, £3.

Course C.—Inorganic Chemistry (Honours Course). Fee, £3.

Course D.—Organic Chemistry. Fee, £3.

Course E—Organic (Honours). Fee, £3.

Course F.—Physical Chemistry. Fee, £2 10s.

Course G.—Honours Physical Chemistry. Fee, £4.

Course H.—History of Chemistry and Chemical Philosophy. Fee, £2.

Courses J.—Applied Chemistry and Metallurgy: Lectures on Technology are given in connection with Laboratory work at hours to be arranged. The subjects are varied in different years. (1) Alkali and Allied Manufactures. (2) General Principles of Metullurgy. (3) Iron, Steel, and Aluminium. (4) Copper, Lead, Silver, and Gold, and other Metals. (5) Fuel and Gas. (6) Technical Gas Analysis.

Course K.—Applied Organic Chemistry.

Course L—Applied Electro-chemistry.

Fee (Courses J, K, L), three terms, £1 10s.

*Practical Classes.*

(1) Junior. (2) Intermediate: Qualitative Analysis of Inorganic Substances and of some of the more common Organic Substances; preparation of Inorganic Compounds. (3) Revision Class. (4) Engineers' Class. (5) General Metallurgy (Elementary).

*Chemical Laboratory.*

The Chemical Laboratories provide accommodation for every kind of chemical and metallurgical work and research. They include thirty rooms devoted to the study of Chemistry and Metallurgy. Separate rooms are provided for Organic Work, Quantitative Analysis, Water and Gas Analysis, Photometry and Photography, Electro-chemical Work, Metallurgy Laboratories, Research Laboratories and Library, and a Museum. Large new Laboratories for Physical Chemistry and Electro-chemistry have been recently erected, and will be opened October 13th.

Students desirous of gaining a thorough theoretical and practical acquaintance with Technical Chemistry, or who intend to adopt Chemical work as a profession, must devote three or four years to special study, for which a full curriculum is provided.

TABLE OF FEES.

| Per Week. | One Term, Three Months. | Three Terms One Session. |
|---|---|---|
| One day . .. .. .. | £4 | £7 |
| Two days .. .. .. | 5 10s. | 10 |
| Three days .. .. .. | 7 | 13 |
| Whole week . .. .. | 10 10s. | 21 |

Pharmaceutical Course (see special syllabus).

D.P.H. Course (see special syllabus).

Course for Dental Degree (see special syllabus).

Veterinary Course (see special syllabus).

*Technological Curriculum.*

The curriculum extends over three or four years.

The Final Examination for the Associateship of the Institute of Chemistry may be taken after the third year. Those students who have taken the Ordinary Degree of B.Sc. may pass the M.Sc. Exam. in any subsequent year.

The Sheridan Muspratt Chemical Scholarship of £50 per annum, tenable for two years, will be competed for in December, 1906, on an Examination in subjects which are included in the first two and a half years of the above curriculum. Candidates should send in their names to the College Secretary not later than November 15. Other Scholarships, Entrance Scholarships, and Free Studentships are also available to Students.

*Evening Classes.*

Classes, including laboratory work, will be held during the winter.

Prospectuses containing particulars may be obtained from the Registrar, University of Liverpool.

## ARMSTRONG COLLEGE, NEWCASTLE-ON-TYNE

*Professor of Chemistry*—P. Phillips Bedson, M.A. D.Sc., F.I.C., F.C.S.

*Lecturer in Chemistry*—F. C. Garrett, D.Sc., F.C.S.

*Lecturer in Agricultural Chemistry*—S. Hoare Collins, F.I.C., F.C.S.

*Assistant Lecturer and Demonstrator*—J. A. Smythe, M.Sc., Ph.D.

*Demonstrator*—A. A. Hall, M.Sc., Ph.D.

*First Year Courses.*—I. *General Course.*—This Course of Lectures will extend over the three terms of the Session, and is intended to serve as an introduction to the Science. The Lectures will be of an elementary character, and whilst framed to meet the requirements of First Year Students will also be serviceable to such as intend pursuing Chemistry in its various applications in the arts and manufactures, as, for instance, Brewing, Metallurgy, the Manufacture of Soda, Soap, Glass, &c. The subjects treated will include an exposition of the Principles of Chemistry, and a description of the preparation and properties of the chief Elementary Substances, both metallic and non-metallic, and their more important native and artificial compounds. The class will meet on Mondays, Wednesdays, and Fridays, at 11 a.m., and will commence on Wednesday, October 4th. Fee, £3 10s. for the Session.

II. *Special Course.*—More advanced than the above. Wednesdays and Fridays, 11 to 12. Fee, £3 10s. for Session.

*For Diploma in Electrical Engineering.*—Tuesday, 12 to 1. A course of Lectures will be given dealing with the Principles of Chemistry, Fuel, the Phenomena of Combustion, and Metals and Alloys employed in Engineering, &c. Fee for the course, £2.

*Second Year Courses.*—The Lectures for the second year students consist of a course of Lectures on Organic Chemistry, and a course of Lectures on Inorganic Chemistry. The class on Organic Chemistry will meet on Tuesdays and Thursdays at 11 a.m., and will commence on October 3rd. The class for Inorganic Chemistry meets at 11 a.m. on Mondays. Fee for Session, £3 10s.; for Inorganic alone £1 10s.; and for Organic alone £3.

*Third Year Courses.*—Advanced Classes are held for the study of Inorganic, Organic, and Theoretical Chemistry. Fee for the course, £3 10s.

A Lecture Course in Analytical Chemistry will be given on Fridays, at 9.15 a.m. Fee for the course, £1.

*Metallurgy and Assaying.*—Lecturer, Professor Louis, M.A., F.I.C., F.C.S.; Demonstrator, H. Dean, A.R.C.M. A Metallurgical Laboratory is provided, in which instruc-

tion is given in the ordinary processes of Dry Assaying, and in the preparation and analysis of Alloys, &c. Fees as for Chemical Laboratory.

*Agricultural Chemistry.*—The instruction in this branch of Chemistry will consist of a series of Lectures and of special practical work in the Chemical Laboratory. Students will be expected to have a knowledge of Elementary Chemistry, such as may be obtained by attending the General Course.

The Lecture Course in Agricultural Chemistry is arranged for two days a week throughout the Session. Fee, £3 10s.

*Practical Chemistry.*—The Laboratory is open from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it closes at 1 p.m. *Laboratory Fees.*—Students working two days, £3 10s. per term, £9 per session; one day per week, £2 per term, £5 per session.

*Courses of Study.*—Students will be divided into two classes:—(1) Regular, or Matriculated Students, who are also Members of the University of Durham; and (2) Non-Matriculated Students. Regular Students will be required to follow such a course of study in the subjects professed in the College as will enable them to pass the Examinations for the degree of Bachelor in Science of the University of Durham. Non-Matriculated Students will attend such classes as they may select. Every candidate for admission as a matriculated student must pass an examination on entrance, in the following subjects:—Arithmetic; English Essay; Geometry; the subject-matter of Euclid, Books I., II., III.; Algebra, up to and including Quadratic Equations. Also any two of the following:—English Language; Latin, including Grammar and Easy Sentences; Greek; French; German; Geography. The next examination commences on September 24. Names to be sent in at least ten days before this date. Registered students in medicine are exempted from this examination, or students who produce a certificate of having passed either of the three following examinations:—1. The first examination for the Degree of B.Litt. 2. Durham Examination for certificate of proficiency in General Education, held in March and September. 3. Durham Examination for Students in Arts in their first year, or any examination of a similar nature that may be accepted by the Council.

The University has recently adopted a Matriculation Examination for students entering the Faculty of Science, particulars of which can be obtained from the Secretary.

*Bachelorship in Science.*—Every candidate for the Bachelorship in Science will be required to satisfy the examiners in Mathematics, Physics, Chemistry, and either Geology or Natural History—in an examination to be held at the end of the candidate's first year, and at the end of the third year in an examination in one chief and two auxiliary subjects. For details of the subjects the College Calendar should be consulted. Candidates may qualify for the degree of B.Sc. by attending special courses in Agriculture, Engineering, and Mining, and passing the several examinations.

*Exhibitions.*—Two Exhibitions of the value of £20 and £10 respectively will be awarded in September next to Candidates desirous of attending the first year course of study in the College.

The examination will be held at the College, and will commence on Monday, September 25th.

*Evening Lectures.*—Courses of Evening Lectures will be given, with a Practical Class for Laboratory instruction.

Several valuable Scholarships are available for students, including the Johnston Chemical Scholarship of the value of £60 for one year, which is open to Bachelors of Science of any British University; the examination for this Scholarship will be held during the week commencing October 1st. Candidates should send in their names to the Secretary on or before September 20th.

## THE UNIVERSITY OF MANCHESTER.

*Professor and Director of the Chemical Laboratories*—Harold B. Dixon, M.A., M.Sc., F.R.S.

*Professor of Organic Chemistry*—W. H. Perkin, Ph.D., F.R.S.

*Lecturers and Demonstrators*—G. H. Bailey, D.Sc., Ph.D.; D. L. Chapman, B.A.; Norman Smith, M.Sc.

*Assistant Lecturers and Demonstrators*—E. C. Edgar, D.Sc.; C. Weizmann, Ph.D.; H. F. Coward, M.Sc; Ida Smedley, D.Sc.

*Lecturer in Organic Chemistry*—J. F. Thorpe, Ph.D.

*Professor of Metallurgy*—H. C. Carpenter, M.A., Ph.D.

*Lecturer in Electro-Chemistry*—R. S. Hutton, D.Sc.

The Session begins October 2, 1906.

The Chemical Classes form part of the Courses for Degrees in the University.

### *Chemistry Lecture Courses.*

*General Chemistry Course.*—Tuesdays, Thursdays, and Saturdays, at 9.30, during the two Winter Terms.

*Introduction to Organic Chemistry.*—Wednesdays and Fridays, at 9.30, during the Lent Term.

These courses are intended for Students commencing the study of chemistry.

*First Year Honours Course.*—Mondays, Wednesdays, and Fridays, 11.30, during the two Winter Terms. The Non-Metals.

*Second Year Honours Course.*—Mondays, Wednesdays, and Fridays, at 2, during the two Winter Terms. The Metals.

*Third Year Honours Course.*—Theoretical and Physical Chemistry.

*Organic Chemistry (General).*—Mondays and Fridays, at 9.30, during the two Winter Terms.

*Organic Chemistry (Advanced).*—Tuesdays and Wednesdays, at 9.30, during the two Winter Terms.

*History of Chemistry.*—Short Courses during the two Winter Terms.

*Metallurgy.*—Introductory Course, followed by either—(A) Lead, Copper, Bismuth, Antimony, Zinc, and Tin; or (B) Iron and Steel. Each Course, one Lecture per week during the Session.

*Electro-chemistry.*—General Theoretical Course: Two hours per week during the Michaelmas Term.

Applied Electro-chemistry: One hour per week during Lent and Easter Terms. A course of six lectures on the Electric Furnace and its Applications will be given on Saturday afternoons during the Michaelmas Term.

*Applied Chemistry.*—(1). Sulphuric Acid and Alkali Manufactures; General Principles of Chemical Engineering. (2). The Natural and Artificial Colouring Matters and the Principles of Dyeing and Printing. (3). The Chemistry of Fuel.

### *Chemistry Laboratory Courses.*

During the first year, the student works in the "Roscoe" or the "Dalton" Laboratory at Qualitative Analysis and Inorganic Preparations. Second Year Students work at Quantitative Analysis, and also take a Laboratory Course in Physics or some other subject. Third Year Students work in the "Schorlemmer" Laboratory of Organic Chemistry, and may also undertake experimental work in some special branch of Chemistry.

The Chemical Laboratories are open daily from 9.30 a.m. to 4.30 p.m., except on Saturdays, when they are closed at 12.30 p.m.

*Metallurgical Laboratory.*—This has been recently much enlarged and re-equipped, mainly with a view to post-graduate work on the Structure of Metals and the Chemistry of Fuel.

*Applied Organic Chemistry.*—In connection with the "Schorlemmer" and "Schunck" Laboratories, a special laboratory is fitted with apparatus and appliances suitable for investigations on Dyes and other organic substances on a large scale.

*Electro-chemical Laboratory.*—In addition to such apparatus as is required for experimental work on Electrolysis

and the Electro-deposition of Metals, special equipment is provided for investigations with the Electric Furnace.

*Chemical Research.*

In addition to the facilities mentioned above for Metallurgical and Electro-chemical Research, the following laboratories are available for post-graduate work:—(1) The private Laboratories of the two Professors; (2) The "Frankland" Laboratories for Physical Chemistry; (3) The "Schunck" Laboratory for Organic Chemistry; (4) The "Thorpe" Laboratory for Organic Chemistry.

To encourage post-graduate work of this kind, the University gives a "Beyer" Fellowship (£100 per annum) and Scholarships (£50 per annum).

The "Dalton" Chemical Scholarship (£50 per annum, tenable for two years) is also awarded, and the 1851 Exhibition Scholarships (£150) may be held in the Laboratory. Further, Honorary Research Fellowships and Research Studentships are granted from time to time to those who are capable of carrying out original investigations.

Two "Schunck" Research Assistants are appointed annually.

*Courses for Degrees.*

To qualify for the Ordinary Degree of B.Sc. Students have to attend a prescribed course of study extending over three years, and are recommended to pass the Matriculation Examination before entrance. (Subsequent to October, 1906, three years attendance *after* matriculation will be compulsory).

The course of the Degree of B.Sc. with Honours in Chemistry is as follows:—First year: First year Honours Lectures; Mathematics (3 hours a week); Physics (3 hours a week); an additional course (3 hours a week); Chemical Laboratory (3 days per week). Second year: Second year Honours Lectures; General Organic Lectures; Physical or some other Laboratory (1 day per week); Chemical Laboratory (3 days per week). Third year: Third year Honours Lectures; Lecture course in some Special Branch of Chemistry; History of Chemistry; Chemical Laboratory (5 days per week, for one of which attendance in another Laboratory may be substituted).

For the M.Sc. Degree post-graduate work is required. The D.Sc. may be obtained after four years from graduation, provided that the candidate has distinguished himself in research.

*Certificate in Applied Chemistry.*—The course extends over three years, and comprises systematic instruction by means of lectures and practical work in the laboratories.

For further particulars of any of these courses apply to the Registrar, Edward Fiddes, M.A.

## UNIVERSITY COLLEGE, NOTTINGHAM.

Departments of Chemistry and Metallurgy.

*Professor of Chemistry*—F. Stanley Kipping, Ph.D., D.Sc., F.I.C., F.R.S.

*Demonstrators of Chemistry*—R. M. Caven, D Sc., F.I.C.; G. Sand, Ph.D., M.Sc.; and R. E Rose, Ph.D.

The Classes of the College are open to students of both sexes above sixteen years of age.

The Session commences October 1st, for both Day and Evening Classes.

*Lecture Courses.*—The Chemistry Day Lectures extend over three years. In the first year a student enters for the course on Elementary Chemistry. In his second year he attends Lectures on both Inorganic and Organic Chemistry. In his third year he attends courses on Advanced Organic Chemistry, Physical Chemistry, and Advanced Inorganic Chemistry.

The fees for the Day Lectures and Classes are as follows: First year, two Lectures per week, 15s. per term. Second year, three Lectures per week, 22s. 6d. per term. Third year, four Lectures per week, 30s. per term.

Demonstrations and Lectures on Analytical Chemistry are given, and Chemical Calculation and Tutorial classes are also held. Various short courses of lectures on special subjects are delivered during the Session.

Students may qualify themselves by attendance at these lectures and classes for the Examinations of the Universities of London, Cambridge, or Oxford, and for the Medical Examinations of the Royal College of Surgeons and of the Universities of Cambridge and Edinburgh: they may also obtain instruction in Chemistry for technical or other purposes, and can enter for a full Chemical Engineering Curriculum. Special attention is given to the requirements of candidates for the Associateship of the Institute of Chemistry.

*Practical Chemistry and Metallurgy.*—The Chemical and Metallurgical laboratories are open every day from 9 to 5, except on Saturday, when the hours are from 9 to 1; also on Tuesday and Thursday evenings from 7 to 9. Each Student works independently of other Students at a course recommended by the Professor. Instruction is given in general Chemical Manipulation, in Qualitative and Quantitative Analysis, and in the methods of Original Chemical Investigation and Research; Students are also enabled to work out the applications of Chemistry to Pharmacy, Metallurgy, Dyeing, Agriculture, Brewing, Iron and Steel, Tanning, and other Manufacturing Processes. Fees for day students: For one term, £7; for the session, £18; for six hours weekly 40s., and 5s. extra for each additional hour per week. For evening students, 10s. for two hours per week, three hours 15s., four hours 20s., per term.

*Research Work.*—Students or others wishing to undertake research work in pure or Applied Chemistry will be afforded every facility for doing so and may be admitted at reduced fees. The Laboratories are fully equipped with apparatus and chemicals necessary for such work.

*Courses of Technical Chemistry Lectures* are also given on Engineering, Dyeing and Bleaching, Brewing, Plumbing, Bread-making, Gas Manufacture, and on other processes of applied Chemistry.

*Pharmaceutical Students* are provided with Lectures and Laboratory work suitable for the preparation for the Minor and Major Examinations.

*Evening Classes.*—Evening Lectures and Laboratory instruction will be given in Pure and Applied Chemistry, and the laboratories are open for practical work on Tuesday and Thursday evenings from 7 to 9. Fee for each Lecture Course, 5s.; for each Laboratory Course, 10s.

Full information concerning all College Classes is given in the College Prospectus, price one penny.

## THE UNIVERSITY OF SHEFFIELD.

*Professor of Chemistry*—W. P. Wynne, D.Sc., F.R.S.

*Lecturers and Demonstrators*—A. N. Meldrum, D.Sc.; W. E. S. Turner, M.Sc., B.Sc.; W. J. Jarrard, B.Sc.

The Session will commence October 3rd.

*Matriculation Course.* — Tuesday and Friday at 9.30. Fee, £2 12s. 6d., and three hours per week Laboratory work.

*Intermediate Course for B.Sc. or M.B.*—Monday and Thursday at 9.30 a.m.; Tuesday and Friday at 10.30 a.m. £4 4s. and nine hours per week Laboratory work.

*B Sc. Course.*—Monday and Wednesday, and another hour to be arranged, £4 4s., and twelve hours per week Laboratory work during two Sessions.

A Course of Lectures, with a special class in Laboratory Work, is arranged for Medical Students entering for the Conjoint Board Examinations. Fee, £7 7s.

*Laboratory.*—Working hours to be arranged between Professor and Students.

Sessional Fees for Day Students:—Three hours per week, £3 3s.; Six, £5 5s.; Nine, £7 7s.; Twelve, £9 9s.; Eighteen, £12 12s.; Twenty-four, £14 14s.; Thirty-two, £16 16s.

Students joining the Laboratory at Christmas will be charged two-thirds and at Easter one-third of the Fees for the whole Session.

A course of Elementary Practical Physics and Practical Chemistry, which will meet the requirements of candidates for the Diploma of Public Health will be held during the Michaelmas and Lent terms. Fee £5 5s.

An arrangement has been entered into with the Board

of Education, South Kensington, which will enable Science Teachers to work in the Chemical Laboratory for three, six, or twelve hours a week on payment of one-quarter of the usual fee, the Board being willing to pay the remainder under certain conditions, of which full information may be obtained on application to the Registrar.

*Evening Classes.*—Lecture Class and Laboratory, on Wednesday evening during the Michaelmas and Lent terms. Fee, £1 10s.

DEPARTMENT OF METALLURGY.

*Professor of Metallurgy*—J. O. Arnold. This Department has been equipped to meet the requirements of the local industries. The Laboratory is fitted with the most modern apparatus for metallurgical analysis, more especially with appliances for the rapid and accurate chemical examination of Iron and Steel, Fuel, and Refractory materials. It also contains a complete pyrometric installation, and a laboratory for the study of the micrographic analysis of metals fully equipped with specially designed microscopes by Ross, polishing tables, etching appliances, incandescent light for evening work, &c. The School is now the most complete of its kind for teaching the practical manufacture, the chemical constitution, and the physical properties of Steel. Special attention is given to the determination of the microscopic constituents of Steel. Although the chief industry of the district occupies the central position in the course of instruction, general metallurgy is not neglected. but is dealt with in a separate syllabus, dealing with metals (other than iron and steel) used in the arts. Students are thus enabled to select and at once enter upon a course of scientific metallurgical training of immediate practical utility. They may take up and work through any portions of the course, but certificates will be granted only to those who follow the prescribed courses, and pass the necessary examinations. Lectures on Iron and Steel Manufacture, on Fuel and Refractory Materials, and on General Metallurgy. Practical Metallurgy:—Laboratory, Furnaces, Foundry, and Testing Machine Course; Practical Course of Metallurgy other than Iron and Steel; Practical Fuel Course for Students in Collieries or Gas Works.

A new steel works has recently been erected in connection with the Sheffield College at a cost of about £10,000. The works include a two ton open-hearth furnace, a one ton Bessemer plant, and a four-hole crucible melting plant. The works is also provided with a hammer capable of dealing with four-inch ingots Differential annealing furnaces, oil brightening and lead-tempering tanks will constitute part of the new plant. Additional laboratory accommodation is attached to the works, viz., chemical laboratory for staff, chemical laboratory for post graduate students, together with a complete magnetic laboratory for hysteresis, &c.

## UNIVERSITY COLLEGE, DUNDEE.

UNIVERSITY OF ST. ANDREWS.

*Professor of Chemistry*—James Walker, Ph.D., D.Sc., F.R.S.

*Assistant Lecturers*—J. S. Lumsden, Ph.D., D.Sc., and J. K. Wood, D.Sc.

*Lecture Assistant and Laboratory Steward*—J. Foggie, F.C.S.

The Winter Session begins early in October and ends in March. The Summer Session extends from the middle of April to the end of June.

*The Junior Lecture Course on Systematic Chemistry* is given daily during the Winter Session, and embraces the Elements of Inorganic and of Organic Chemistry.

*Advanced Courses*, of about fifty lectures each, will be given during the year as follows:—

Organic Chemistry; Inorganic Chemistry, including the more important technological applications; Theoretical and Physical Chemistry; Bleaching and Dyeing, including the Chemistry of the Textile Fibres.

Practical Instruction in all of the above branches will be given in the Laboratories and Dye-house. Special facilities are afforded to Research Students.

## UNIVERSITY OF ABERDEEN.

CHEMISTRY.

*Professor*—Francis R. Japp, M.A., LL.D., F.R.S.

*Demonstrators*—Francis W. Gray, M.A., B.Sc., and John Alexander, M.A., B.Sc.

I. *General Lecture Course* (100 *Lectures*),—Daily during the Winter Session. The subjects treated of include (1) The Laws of Chemical Combination and the General Principles of Chemistry; (2) Non-metallic and Metallic Elements, and their Compounds; (3) Organic Chemistry; (4) Applications of Chemistry to the Arts and Manufactures. Fees, for first attendance, £4 4s.; for subsequent attendance, £3 3s. A Tutorial Class (without fee), conducted by the Junior Demonstrator, is held in connection with this course.

II. *Special Lecture Course on Organic Chemistry* (50 *Lectures*).—Daily during the Summer Session. Fee, £3 3s.

III. *Practical Course for Medical Students.*—This course, which occupies five hours a week during the Summer Session—in all fifty hours—is devoted to practice in Elementary Qualitative Analysis. Fee, £4 4s.

IV. *Chemical Laboratory.*—The Laboratory is open to Students daily from 9 a.m. to 5 p.m. Each Student on entering is allowed to arrange his hours of work so as to suit his own convenience, but must adhere to these hours when once fixed. The Laboratory instruction includes: (1) General experiments; (2) Preparations; (3) Qualitative analysis; (4) Quantitative analysis: gravimetric, volumetric, and gasometric. Fee, £4 4s. a session. A certain number of free places are available, on the recommendation of the Professor, and subject to the approval of the Senatus, for research students.

V. *Physical and Advanced Inorganic Chemistry* (30 *Lectures.*—In connection with the Laboratory work, three Lectures a week on Physical Chemistry and selected portions of Advanced Inorganic Chemistry are delivered during the Winter Session by the Lecturer, Mr. F. W. Gray. Fee, £2 2s.

UNIVERSITY OF ABERDEEN AND ABERDEEN AND NORTH OF SCOTLAND COLLEGE OF AGRICULTURE.

*Agricultural Chemistry.*

*Lecturer*—James Hendrick, B.Sc., F.I.C.

*Assistants*—R. Glegg, B.Sc., F.I.C.; W. J. Profeit, M.A., B.Sc.; and H. M. Will. M.A., B.Sc.

I. Preparatory Courses in General Chemistry and in Organic Chemistry are given for those who are unable to take the full University Courses in these subjects. The course in General Chemistry consists of about sixty Lectures with Practical Work (one hour daily) during the Winter Session. The course deals with the general principles of Chemistry, and with those parts of Inorganic Chemistry which are of more immediate concern to students of Agricultural Chemistry. The Practical Work goes along with and illustrates the Lectures. Fee, £4 4s.

The course in Organic Chemistry consists of about thirty Lectures, and is given during the Winter Session. It deals especially with those parts of the subject which are directly related to Agricultural Chemistry. Fee, £1 1s.

II. *Agricultural Chemistry* (*General Course*).—This class meets daily during the Winter Session, and includes both Lectures and Laboratory Work. The Lectures deal with the Chemistry of the Atmosphere, the Soil, Manures, Foods, Preservatives, Insecticides, &c. The Physiological Chemistry of Plants and Animals, the Composition and Manurial Requirements of Crops, and Dairy Chemistry are also treated of. The Laboratory Work is primarily intended to accompany and illustrate the Lectures. Exercises dealing with the properties and composition of Soils, Manures, Feeding-stuffs and Waters, and with the impurities and adulterations of these, occupy much of the time given to Practical Work. The fee for the whole Course (Lectures and Practical Work) is £4 4s.

III. *Laboratory.*—A Summer Course in Practical Chemistry is given to prepare students who have not previously done sufficient laboratory work for the course in Agricultural Chemistry. Fee, £2 2s.

IV. The Laboratory is open daily from 9 a.m. to 5 p.m. for students who wish to study the principles and practice of Agricultural Chemistry or to undertake research in this subject.

## UNIVERSITY OF EDINBURGH.

### Department of Chemistry.

*Professor*—Alex. Crum Brown, M.D., D.Sc., F.R.S.

*Lecturers*—L. Dobbin, Ph.D.; H. Marshall, D.Sc.; and W. W. Taylor, M.A., D.Sc.

The working terms are—Winter Session, from middle of October to middle of March; Summer Session, from beginning of May to middle of July.

*Lecture Courses.*—During the Winter Session a General Course of Chemistry for medical and science students is given by the Professor. The class meets daily; fee £4 4s. Advanced Courses of 25 lectures each are given in the Winter and Summer Sessions; fee, £1 1s. An Intermediate Course of Organic and Advanced Inorganic Chemistry is held in summer; fee, £2 2s. There is also a class on History of Chemistry or Chemical Theory, by Dr. Dobbin; fee £1 1s.: and a class on Mineralogy and Crystallography, by Dr. Marshall; fee, £2 2s. All these Lectures, except the General Course, are now open to women.

In addition to the above, Lecture Courses are from time to time given by the Assistants on particular branches of Organic and Inorganic Chemistry. These Lectures are free to Laboratory Students.

*Laboratories.*—Practical classes for Medical Students meet during the Winter Session and in the Summer Session. (Fee, £3 3s.) The laboratories for Science and Arts Students engaged in analytical and advanced practical work are open daily from 9.30 till 4.30. (Fees: Whole Day—Winter Session, £10 10s.; Oct.-Dec., Jan.-March, or Summer Session, £5 5s. Half Day—Winter Session, £6 6s.; Oct.-Dec., Jan.-March, or Summer Session, £3 3s. Preference will be given to students in the above order. Full Courses of instruction are given in Analytical, Practical Organic and Inorganic Chemistry (including Gas Analysis), Physico-chemical Measurements, Agricultural Chemistry, and Assaying. Facilities are afforded to advanced students who desire to undertake chemical investigations.

Various prizes and scholarships are attached to the laboratory and general class.

*Graduation.*—Two Degrees in Pure Science are conferred, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.).

Candidates for Degrees in Science, if not graduates (by examination) in Arts in one of the Universities of the United Kingdom or in a Colonial or Foreign University recognised for the purpose by the University Court, must pass a preliminary examination in (1) English; (2) Latin, Greek, French, or German; (3) Mathematics; (4) One of the languages Latin, Greek, French, German, Italian, not already taken under (2), or Dynamics. In the case of a student whose native language is other than European, the Senatus may, at the Preliminary Examination, accept such language as a substitute for a modern European language. The Senatus may also in such a case accept as an alternative to Latin or Greek any other classical language, such as Sanscrit or Arabic.

The First B.Sc. Examination embraces Mathematics, or Biology (*i.e.*, Zoology and Botany), Natural Philosophy, and Chemistry. The Final B.Sc. Examination in Pure Science includes any three or more of the following subjects:—Mathematics, Natural Philosophy, Astronomy, Chemistry, Human Anatomy (including Anthropology), Physiology, Geology (including Mineralogy), Zoology (including Comparative Anatomy), and Botany (including Vegetable Physiology). In the Final Examination two written papers are set in each subject professed, the second of a higher standard than the first. Candidates must pass the first section in all, and the second section in at least one, of the subjects professed; the same regulations apply also to the Practical and Oral Examinations. Chemistry in this examination embraces Inorganic, including Mineralogical Chemistry; Organic Chemistry; Physical Chemistry; Chemical Crystallography; History of Chemistry. In the written papers a choice of questions is allowed, so as to adapt the examination to the various courses of advanced study which candidates may have selected. Practical Examination:—Complex Qualitative Analysis; Inorganic Preparations; Gravimetric and Volumetric Analysis. Each candidate taking the higher standard will also be examined on Organic Preparations, Ultimate Organic Analysis, and one of the following subjects, selected by himself:—Gas Analysis; Assaying; Physico-chemical Measurements.

A candidate for the D.Sc. Degree must submit a thesis on original work done by him. The Thesis must be approved before the candidate is allowed to proceed to Examination. The candidate in Chemistry *may be* required to pass a searching examination in one of the following branches:—(1) The Chemistry and Chemical Technology of Inorganic Bodies, including Metallurgy; (2) Organic Chemistry; and to show a thorough practical acquaintance with chemical analysis in all its branches, and with the preparation of pure substances.

## HERIOT-WATT COLLEGE, EDINBURGH.

*Principal*—A. P. Laurie, M.A., D.Sc., F.R.S.E.

*Professor*—John Gibson, Ph.D., F.R.S.E.

Assisted by the following Lecturers and Demonstrators:—R. B. Denison, M.Sc., Ph.D.; Archibald Boon, B.A., B.Sc.; Andrew F. King, F.I.C.; E. B. R. Prideaux, M.A., D.Sc.

The Session begins October 2nd, 1906.

The curriculum of this College comprises both Day and Evening Classes, each department providing the higher general and technical education.

The Chemistry Course is designed to meet the wants of Manufacturing Chemists. The instruction consists of Courses in Chemistry, Physics, Mathematics, Engineering, and Mechanical Drawing, with Special Courses in Gas and Paper Manufacture, Brewing, &c., by Experts, in the fourth year. Special attention will be paid to Electrochemistry. The Chemistry Classes are recognised by the University as qualifying for the B.Sc., in Chemistry, and are also recognised by the Institute of Chemistry.

For Students who have been three and four years in the Chemistry Department, arrangements have been made for their spending from four to twelve months in the laboratories of the Corporation's Gas Works, with a view to the study of problems connected with the Combustion of Fuel, the Manufacture of Coal-gas and its By-products, &c.

A Laboratory, under the charge of Dr. Emil Westergaard, has been provided for the study of Technical Mycology, including Brewing, Distilling, Malting, Vinegar Making, Tanning, Preserving, Starch and Sugar Making, Bread Making, Butter and Cheese Manufacture, &c.

Matriculation Fee, 5s.; Composition Fees from £12 12s. to £15 15s. Full particulars are published in the Calendar of the College, which is issued early in September.

## GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE.

*Professor of Chemistry*—G. G. Henderson, D.Sc., M.A.

*Professor of Technical Chemistry*—T. Gray, D.Sc., Ph.D.

*Professor of Metallurgy*—A. Humboldt Sexton, F.C.S., F.R.S.E.

Also, Professors and Lecturers in the other leading branches of Pure and Applied Science and Technology.

Session opens Sept. 25. Entrance Examination Sept. 17.

The main objects of this College are to afford a suitable education to those who wish to qualify themselves for following an industrial profession or trade, and to train teachers for technical schools. It was founded by an Order in Council, dated 26th November, 1886, according to a scheme framed by the Commissioners appointed under the provisions of the Educational Endowments (Scotland) Act, whereby Anderson's College, the Young Chair of Technical Chemistry in connection with Anderson's College, the College of Science and Arts,

Allan Glen's Institution, and the Atkinson Institution were placed under the management of one governing body.

The Diploma of the College is awarded to Day Students who have attended prescribed courses of instruction and passed the necessary examinations. The ordinary courses extend over three years, but arrangements are made for advanced students continuing their studies in special departments. The diploma course in Chemistry extends over four years.

Complete courses of instruction are provided in both Day and Evening Classes.

Copies of the Calendar for 1906-1907 may be had from Mr. H. F. Stockdale, Secretary; price by post, 1s. 4d. Prospectuses will be sent free.

## UNIVERSITY OF ST. ANDREWS.

### United College of St. Leonard and St. Salvator.

*Professor of Chemistry* — T. Purdie, B.Sc., Ph.D., LL.D., F.R.S.

The Session begins on October 15th. A Competitive Examination, open to intending Students of Arts, Science, and Medicine, for forty Bursaries, ranging in value from £40 to £10 each per annum, will be held on September 28th and following days. Twenty-one of these Bursaries are restricted to Men, two to Men or Women, and fourteen to Women, the latter being intended for women who at the conclusion of their Arts or Science Course will proceed to Medicine.

A Hall of Residence is provided for Women Students.

Two Degrees in Science are conferred by the University of St. Andrews, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.), and Chemistry is also included in the curriculum for the M.A. Degree; the regulations will be found in the "University Calendar."

*Lecture Courses.*

Two distinct Courses of Lectures are given, each comprising at least one hundred meetings of the class.

*First Year's Course.*—This Class meets at 11 o'clock on five days in the week. The introductory lectures treat of the Nature of Chemical Action, the Classification of Substances into Elements and Compounds, the Phenomena of Oxidation, and the Composition of Air and Water. The Laws of Chemical Combination and the Atomic Theory are next discussed, after which the more commonly occurring elements and inorganic compounds are described systematically. Elementary Organic Chemistry is also included in the Course.

The chemistry of manufactures is referred to only cursorily; special attention, on the other hand, is given to those parts of the science which are of general educational value, and as much of the theory of chemistry is introduced as is compatible with elementary treatment.

This course of instruction is intended to meet the requirements of the M.A., First Science, and M.B., Ch.B. Exams., so far as Theoretical Chemistry is concerned.

*Second Year's Course.*—The first part of the Course is devoted to Organic Chemistry, and the second part to General and Physical Chemistry, the instruction in general being such as is required for the Final Science Exam.

Certificates are awarded on the results of examinations, and the "Forrester Prize" of about £10 is awarded to the best Student of the year.

Fee for the Session, for each Course, £4 4s.

*Practical Chemistry.*

The Laboratory is open daily from 9 a.m. to 4 p.m., except on Saturdays, when it is closed at 1 p.m. The work pursued in the Laboratory comprises:—(1) The performance of experiments illustrative of the Principles of Inorganic and Organic Chemistry; (2) Qualitative and Quantitative Analysis. Each student pursues an independent course of study under the supervision of the Professor or Demonstrator, the nature of the work varying with the proficiency of the student and the particular object he may have in view. Suitable courses of instruction in Practical Chemistry are provided for candidates for the Examinations in Arts, Science, and Medicine.

The fee for the Ordinary Course of Practical Chemistry is £3 3s, and for the Advanced Course £5 5s.

A special Research Department has been instituted by the University, the laboratories of which are open to students who give proof of their capacity of conducting chemical investigation.

## QUEEN'S COLLEGE, BELFAST.

*Professor* — E. A. Letts, Ph.D., D.Sc., F.R.U.I., F.R.S.E., &c.

I.—*Chemistry.*—The lectures are delivered at 3 p.m., on the first five days of each week, and terminate at the end of March The course is divided into three parts:—(1) Chemical Philosophy; (2) Inorganic Chemistry; (3) Organic Chemistry. Fee, £2.

II.—*Practical Chemistry.*—In this course the Students are instructed in the general methods of conducting Chemical Analyses. Fee, £3.

III.—*Laboratory Pupils.*—The Chemical Laboratory is open from November until the end of March, and from May 1st until the third week of July, on the first five days of the week, from 10 a.m. until 4 p.m. Students are admitted as working pupils on payment of a fee of £5 for the first period, or of £3 10s. for the second period (or for a single term).

The new Chemical Laboratories are now open, and are provided with all modern appliances. Special facilities are offered to those engaged in Research work.

*Scholarships.*—The following College Scholarships are awarded specially in connection with the schools of Chemistry and Physics:—Senior Scholarships in Chemistry alone awarded annually of £40, and tenable for one year. Andrews Studentship in Chemistry and Physics, value about £80 annually, and tenable for two years. 1851 Exhibition Scholarships: One of these Scholarships has hitherto been placed at the disposal of the College every two years, of the annual value of £150, tenable for two or under special conditions for three years.

The following Scholarships, &c., of the Royal University of Ireland are awarded in the same group of subjects (Chemistry and Physics):—At the B.A. Degree examination, First-class Exhibitions of £42 each and Second-class Exhibitions of £21. At the M.A. Degree examination, a Studentship of £100 per annum, tenable for three consecutive years. Also a Junior Fellowship, tenable for four years, of the annual value of £200.

## QUEEN'S COLLEGE, CORK.

*Professor*—Augustus Edward Dixon, M.D.

*Demonstrator*—John Hawthorne, Ph.D., F.C.S.

The College Session will commence on October 16th, 1906, and end on June 8th, 1907. All classes are open to male and female students.

The courses in Chemistry, though designed primarily to meet the requirements of candidates proceeding to the Examinations in Arts, Medicine, and Engineering of the Royal University of Ireland, of the Medical Licensing Bodies of Dublin and Edinburgh, and of the Pharmaceutical Society of Ireland, can be arranged specially as required, so as to render them suitable to any particular course of study. The following courses are provided:—

*Systematic Chemistry.*

I. General Lecture Course; three terms. Inorganic Chemistry, Elementary Organic Chemistry, and Chemical Philosophy.

II. Advanced Organic Chemistry, and Chemical Philosophy.

*Practical Chemistry.*

III. Winter Course of Practical Analytical Chemistry; commencing early in January, 1907.

IV. Summer Course of three months' duration, for students of Medicine; ending about the third week in June.

V. Course for Pharmaceutical Students; held during the second and third terms.

*Laboratory Work.*

VI. The Chemical Laboratory is open daily from 10 to 4 o'clock, except on Saturdays, to Students entering for Special Courses of practical work in General Inorganic Chemistry, Qualitative and Quantitative Analysis, Organic Chemistry, or for the purpose of Original Investigation.

*Scholarships, &c.*—In addition to the Class Prizes given at the Sessional Examinations, the College awards a Senior Scholarship of the value of £40, for Chemistry and Physics (either of which may be taken as a limited course), and numerous Junior Scholarships in Arts, Medicine, and Engineering, of which chemistry forms a part, value from £20 to £24 each, annually. The Royal University of Ireland also offers Exhibitions in Chemistry and Physics, First-class value £42, and Second-class value £21, together with other prizes, *e.g.*, a Studentship of £100 per annum, tenable for three years; and the 1851 Exhibition Scholarships, value £150, tenable for two, and, under certain circumstances, for three years, have from time to time been placed at the disposal of the College.

Full particulars as to Lectures, Fees, Scholarships, Exhibitions, &c., are contained in the Regulations extracted from the College Calendar, which will be supplied on application to the Registrar.

## QUEEN'S COLLEGE, GALWAY.

*Professor*—Alfred Senier, Ph.D., M.D., F.I.C., F.C.S.

*Demonstrator*—Miss Rosalind Clarke, B.A.

*Research Assistants*—W. Sloan Mills, M.A., B.E., and Percy C. Austin, M.A.

The Session commences in October and ends in June.

Chemistry is studied by attendance at Lectures, by work in the Laboratories, and by the use of the College Library. The Courses in the several faculties are arranged with a view to the requirements of the Royal University of Ireland, but are adapted also to those of other Universities and licensing bodies.

*Lecture Courses. Faculty of Arts.* — 1. Second year's Course, Inorganic and Organic, and the Elements of General Chemistry. 2. Third year's Course, Advanced Organic Chemistry. 3. Fourth year's Post-Graduate Course, Advanced General Inorganic and Organic Chemistry. *Faculty of Medicine.*—First year's Course, Inorganic and Elementary Organic Chemistry. *School of Engineering.*—First year's Course, Inorganic Chemistry.

*Laboratory Courses. Faculty of Arts.* — 1. Second year's Course, Exercises in Inorganic Qualitative Analysis. 2. Third year's Course, Quantitative Analysis and other experiments to suit the requirements of individual Students. 3. Fourth year's Post-Graduate Course, Advanced Quantitative Analysis, Organic and Inorganic Preparations, and determination of their Physical and Chemical characters. 4. The Laboratories are also open to Students for work in other branches of Chemistry. *Faculty of Medicine.* — 1. Second year's Course, Inorganic and Organic Elementary Qualitative Analysis, and the Chemical Examination of Urine. *School of Engineering.* —1. Second year's Course, Inorganic Qualitative Analysis.

A Scholarship in Chemistry is offered for competition each year of the value of £40, and Chemistry enters into the subjects required for numerous Scholarships in Arts, Medicine, and Engineering. The Royal Commissioners for the Exhibition of 1851 offer every two years a Science Research Scholarship of £150 per annum. This Scholarship has already been held by four Chemistry Students of this College.

For details as to Fees, Regulations as to Scholarships, and other particulars apply to the Registrar, from whom the Calendar, published in December, and the Extracts from Calendar, published in advance in July, may be obtained.

## ROYAL COLLEGE OF SCIENCE, DUBLIN.

*Dean of Faculty and Professor of Chemistry*—W. N. Hartley, F.R.S., D.Sc.

*Lecturer on Organic Chemistry*—Alphonsus O'Farrelly, M.A.

*Senior Assistant*—J. Holms Pollok, D.Sc.

*Junior Assistant*—G. G. Leonard, A.R.C.Sc.I.

The Royal College of Science supplies, as far as practicable, a complete course of instruction in Science applicable to the Industrial Arts, and is intended also to aid in the instruction of teachers for the local Schools of Science.

Diplomas are awarded in the Faculties of Engineering (Mechanical and Electrical), Applied Chemistry, and Agriculture. If accompanied by a certificate from the Professor of Chemistry, the Diploma of Associate of the Royal College of Science in the Faculty of Applied Chemistry is recognised by the Council of the Institute of Chemistry of Great Britain and Ireland as qualifying candidates for admission to the practical examinations of the Institute.

The instruction in Chemical Science includes (1) General Chemistry; (2) Organic Chemistry, Elementary and Advanced; (3) Analytical and Experimental Chemistry; (4) Instruction in Chemical Research.

Fees payable by Non-Associate Students:—£2 for each separate Course of Lectures. For Analytical Chemistry and Research—£5 for three months; £9 for six months; £12 for the entire session. For Assaying—£5 for three months; £9 for six months £12 for the entire session.

There are four Royal Scholarships of the value of £50 each yearly, with Free Education, including Laboratory Instruction, tenable for two years; two become vacant each year; they are awarded on the results of their examinations to Associate Students, not being Royal Exhibitioners, who have been a year in the College.

A limited number of Scholarships in Science and Technology are competed for each year. These Scholarships include free education for the full Associateseip Course of three years and maintenance allowance of a guinea a week during the Session.

# CHEMICAL LECTURES, CLASSES, AND LABORATORY INSTRUCTION.

City and Guilds of London Institute for the Advancement of Technical Education.—The operations of the City and Guilds of London Institute are divided broadly into four branches: the educational work of three London Colleges, and of the Technological Examinations. Programmes of the London Colleges may be had on application to the Head Office of the Institute, Gresham College, Basinghall Street, London, E.C., or from the respective Colleges. The Technological Examinations (Examinations Department, Exhibition Road, S.W.), are conducted once every year at various centres throughout the kingdom. The Programme of the College, containing full particulars of the conditions of entrance, fees, and courses of instruction, may be had on application. *City and Guilds Central Technical College, Exhibition Road.*—Professor of Chemistry, H. E. Armstrong, Ph.D., F.R.S. The object of this Institution is to give to London a College for the higher technical education, in which advanced instruction shall be provided in those kinds of knowledge which bear upon the different branches of productive industry, whether Manufactures or Arts. The main purpose of the instruction given is to practically demonstrate the application of different branches of science to various manufacturing industries. In order that this instruction may be efficiently carried out, the Institution, in addition to the lecture theatres and class rooms, is fitted with laboratories, drawing offices, and workshops; and opportunities are afforded for the prosecution of original research, with the object of the more thorough training of the students, and for the elucidation of the theory of industrial processes. The courses of instruction are arranged to suit the requirements of—1. Persons who are training to become Technical Teachers; 2. Persons who are preparing to enter Engineers' or Architects' offices, or Manufacturing works; 3. Persons who desire to acquaint themselves with the scientific principles underlying the particular branch of industry in which they are engaged. The Matriculation Examinations begin on Tuesday, September 18th, and

the Winter Session opens on Tuesday, October 2nd. *City and Guilds Technical College, Finsbury.*—Professor of Chemistry, Raphael Meldola, F.R.S. The operations of the Technical College, Finsbury, are divided into two distinct portions: Day Classes for those who are able to devote one, two, or three years to systematic technical education; Evening Classes for those who are engaged in industrial or commercial occupations in the daytime and who desire to receive supplementary instruction in the application of Science and of Art to the trades and manufactures in which they are concerned or employed. Each Professor is assisted by Demonstrators. Besides these there are Lecturers and Teachers in special subjects. An examination for the admission of Students will be held at the College on Tuesday, September 18th. Session begins October 2nd. *South London Technical Art School.*—Classes in Modelling, Design, Drawing and Painting, House Decoration.

City of London College, White Street, Moorfields.—I. S. Scarf, F.I.C., F.C.S., and Assistants. Courses of Saturday and Evening Lectures and Laboratory Practice in Chemistry and Physics, open to Students of both sexes. Day Commercial School, commences Sept. 17. Session commences October 1st.

Battersea Polytechnic.—Principal, Mr. Sidney H. Wells, Wh.Sc. Inorganic, Organic, and Technological Chemistry, Mr. John Wilson, M.Sc. (Vict.), assisted by Mr. John L. White, D Sc., Mr. H. Evans, and others. Session opens Sept. 24. Complete courses of Instruction are given in Chemistry (Inorganic and Organic), together with Physics, Electricity, Engineering subjects, German, &c., for intending technological and works chemists. Certain of the Courses (Day and Evening) are recognised by the University of London in preparation for the B.Sc., for which examination (Pass and Honours) complete courses of instruction, under recognised teachers, are provided. Special Evening Courses in Paper and Pulp Testing, Paper Making, Gas Analysis, Assaying, Oils, Fats, Soaps, and Candles.

Birkbeck College, Breams Buildings, Chancery Lane.—Chemistry Courses conducted by Dr. Alex. McKenzie prepare for various Examinations, the B.Sc. and M.B. Degrees of the London University, Conjoint Board, Pharmaceutical Examinations, Board of Education, &c. This Institution, which has now completed eighty-three years of educational work, will commence tht new Session on Wednesday, September 26, when Sir Edward Busk, Vice-chancellor of the University of London, will give the Opening Address, at 7.30 p.m. The Day and Evening courses of study include Chemistry, Physics, Botany, Zoology, Geology, Mathematics, Latin, Greek, Modern Languages, Economics, Geography, Law, and Logic. Courses conducted by recognised teachers of the University provide for the Examinations of the University of London, in the faculties of Arts, Science, Commerce, and Law. The Report for the last session shows that during the year 65 students passed some University examinations, while a large number gained successes at various public examinations. The College has added considerably to its appliances in recent years, and the Physical, Chemical, Biological, and Metallurgical laboratories are very thoroughly equipped. Courses in Mining, Metallurgy, and Assaying are given both in the day and evening. The Modern Language classes include Italian, Spanish, as well as French and German. The College has a School of Art, open both day and evening. Good Reading and Magazine Rooms are provided. The Calendar supplies detailed information respecting the Courses of Study, Examinations, Studentships, &c. A popular Lecture or Entertainment is given in the Theatre every Wednesday evening from October to Apr l.

Brixton School of Chemistry and Pharmacy, 171, Brixton Road, London.—Principal, Dr. A. B. Griffiths, F.R.S.(Ed.). Lectures on Inorganic and Organic Chemistry, Physics, Botany, &c., for Pharmaceutical, Medical, and other students. The benches in the laboratory are fitted with every convenience. There are courses in Research Work. Full particulars as to fees, &c., may be obtained by writing to the Principal.

Borough Polytechnic Institute, 103, Borough Road, S.E. — Chemistry: Evening Lectures and Laboratory Work in Inorganic and Organic Chemistry (Session fees, per course, 10s. to 20s.). Day Practical class in Electro-chemistry, lecture on Friday evenings. Special Saturday Morning Class in Practical Chemistry (10s.); Dr. F. Mollwo Perkin, assisted by H D. Law, B.Sc. Electricity and Magnetism, and Electro-technics: Evening Lectures and Laboratory Work (Session fees, per course, 10s. to 30s.), Dr. J. Henderson, assisted by H. Saunders. Special Evening Courses on Painter's Oils, Colours, and Varnishes. Special Day Courses in Technical Chemistry and Electro chemistry (October to July), £10. Session opens Monday, Sept. 24.

South Western Polytechnic, Chelsea, S.W.—Principal, Sidney Skinner, M.A. Head of the Chemical Department, J. B. Coleman, A.R.C.S., F.I.C. Day and Evening Courses in Theoretical and Practical Chemistry and several branches of Applied Chemistry including Metallurgy, Assaying, Photography, &c. Systematic Courses are held for the Matriculation, Intermediate Science, and B.Sc. Examinations of the University of London. The Day Course in Chemistry is of three years' duration; it gives a thorough training to those who wish to become Consulting or Industrial Chemists. Prospectus of Day and Evening Classes may be obtained from the Secretary, 1d., by post 4d.

East London College, Mile End Road, E.—Chemistry: Professor, J. T. Hewitt, M.A., D.Sc., Ph.D.; Assistants, Clarence Smith, D.Sc., and F. G. Pope, B.Sc. Lectures and Practical Classes are conducted in the Day Technical College, the regular College Course being three years. The work of the first year corresponds with the requirements of the Int. Sci., Lond., that of the next two years with the degree examination, B.Sc. (Honours and Pass). Special attention is given to work for the Honours Examination and research. Evening Classes for London University Degrees are also held. The College re-opens October 1st.

University Tutorial College, 32, Red Lion Square, Holborn, W.C.—This Institution contains large Laboratories for Chemistry, Physics, Geology, and other subjects. Classes are specialised for Examinations of London University, but students may take up work for any Examination. The special feature of the College is that work goes on all the year round, thus affording students residing in the Country an opportunity of doing practical work during their Vacations.

Sir John Cass Technical Institute, Jewry Street, Aldgate.—Principal, Charles A. Keane, M.Sc., Ph.D., &c., assisted by H. Burrows, Ph.D., F.I.C., Arthur R. Ling, F.I.C., R.S. Willows, D.Sc., and C. O. Bannister, A.R.S.M. Evening Classes in Chemistry, Metallurgy, Brewing and Malting, Physics, and Mathematics, designed to meet the requirements of those engaged in Chemical, Metallurgical, and Electrical industries, and also in other departments of Science and Art. Practical laboratory work. Courses of Instruction in Glass Blowing, by A. C. Cossor. Classes begin September 24. Full details may be obtained on application, or by letter to the Principal.

The Institute of Chemistry of Great Britain and Ireland.—The Institute of Chemistry was founded in October, 1877, and incorporated by Royal Charter in June, 1885, (i.) to promote the better education of persons desirous of becoming public and technical analysts and chemical advisers on scientific subjects; (ii.) to examine Candidates, and to grant certificates of competency; and (iii.) to elevate the profession of Consulting and Analytical Chemistry by setting up a high standard of scientific and practical proficiency and by insisting on the observance of strict rules in regard to professional conduct. *The Studentship.*—Every Candidate for admission to the

Studentship is required to produce evidence that he is at least seventeen years of age, and that he has passed a Preliminary Examination in subjects of general education, recognised by the Council of the Institute. He must also show that, at the time of making application for registration, he is working at a College or University approved by the Council, or in the laboratory of a Fellow of the Institute, with the object of adopting the profession of Analytical and Consulting Chemistry. *The Intermediate Examination.*—Candidates for admission to the Intermediate Examination are required to produce evidence (I.) of having passed an approved Preliminary Examination in subjects of general education; (II.) of having regularly attended systematic day courses, in a College or University recognised by the Council, during at least three academic years, in theoretical and practical Chemistry, and courses in Physics, Mathematics, and one of the following subjects, in accordance with the Regulations of the Institute: (i.) Advanced Mathematics; (ii.) Mechanics and Chemical Engineering; (iii.) Metallurgy; (iv.) Geology and Mineralogy; (v.) Physiology; (vi.) Bacteriology; and (III.) of having satisfactorily passed the Class Examinations in all the subjects required to be taken. As an alternative in the matter of training (II.), a candidate may take two years' training in a recognised Institution as indicated above, and work systematically for two other years in the laboratory of a Fellow of the Institute. A Candidate who has taken a Degree in Science (including Inorganic and Organic Chemistry, and Physics in the Degree Examination, Mathematics having been also passed in at either the Final or Intermediate University Examination) in a University recognised by the Council, is eligible for admission to the Intermediate Examination of the Institute. Holders of certain Degrees or Diplomas are exempt from passing the Intermediate, and, by virtue of their qualifications, are eligible for admission to the Final Examination direct. *The Final Examination for the Associateship (A.I.C.).*—Any Candidate who has passed the Intermediate Examination of the Institute, or who is entitled to claim exemption from passing the Intermediate Examination, is eligible for admission to the Final Examination. *Fellowship (F.I.C.).*—For admission to the Fellowship, an Associate is required to have been registered for three years, and to have been continuously engaged during that period in the study and practical work of Applied Chemistry in a manner satisfactory to the Council. Full particulars are given in "The Book of Regulations for the Admission of Students, Associates, and Fellows," which may be obtained (Price One Shilling) of Messrs. Blundell, Taylor, and Co., 173, Upper Thames Street, London, E.C.

Imperial College of Chemistry and Pharmacy, 49 and 51, Imperial Buildings, Ludgate Circus.—Mr. F. Davis, B.Sc. An especial course of instruction is given at this College in Pharmacology and Therapeutics, *vs* the Institute of Chemistry Examination. Students attending the College visit technical works.

The Polytechnic, 309, Regent Street, W.—University of London Preparation Classes. Chemistry: R. A. Ward, F. E. Weston, B.Sc., F. Harvey, W. H. Collier, and H. R. Ellis, B.Sc.

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Blackburn Municipal Technical School.—Chemistry: Mr. Robert H. Pickard, D.Sc.(Lond.)., &c., assisted by Messrs. Jos. Yates, W. O. Littlebury, A.I.C., and Jos Kenyon. Session opens Monday, Sept. 10. Full details of the Classes are given in the "Students' Handbook," which may be had at the Institution (price 1d., by post 2½d.).

Redruth School of Mines, Cornwall.—Principal, Howard C. Ridding, A.R.S.M., F.I.C., assisted by a staff of Mining Engineers and Mine Surveyors Courses of Practical and Theoretical instruction are given in Inorganic Chemistry, Assaying, Mineralogy, Blowpipe Analysis, Mine Surveying, Geology, Principles of Mining, Ore Dressing, Mechanical Engineering, &c., for intending Assayers, Mineral Chemists, Mining Engineers, and Surveyors. Shorter Courses are also held in the above-named and cognate subjects to meet the requirements of those having a limited time at their disposal and Prospectors. Practical instruction in Mining given at the Basset Mines, Ltd. Syllabus on application to the Registrar. Session commences Wednesday, Sept. 12.

County Technical Laboratories, Chelmsford.—The new buildings are now open, and comprise facilities for practical instruction in Chemistry and Biology in their relation to Agriculture. Lecturer in Agricultural Chemistry: G. Clarke, F.I.C., assisted by H. Neville, B.Sc., A.I.C., V. H. Kirkham, B.Sc., A.I.C., and others. Prospectus free on application.

Leeds Institute: Technical School, Cookridge Street, Leeds.—Head Master, R. E. Barnett, B.Sc. (Lond.), A.R.C.S. Evening Classes are held in over sixty subjects of Science and Technology, among which are:—Chemistry (Inorganic and Organic), Chemical Calculations and Principles of Analysis, by Mr. R. E. Barnett, B.Sc., A.R.C.S., Mr. J. B. Murray, Mr. A. McFarlane, and Mr. F. R. Penn; Metallurgy (Theoretical and Practical) and Iron and Steel Manufacture, by Mr. B. A. Burrell, F.I.C., F.C.S.; Gas Manufacture, by Mr. W. E. Pettigrew; Oils and Fats, by M. W. Dillon; Magnetism and Electricity, Practical Physics, &c., by Mr. J. E. Tindall, B.A., B.Sc.; Botany, Lectures and Practical Work, by Mr. N. Walker; Photography, by Mr. S. E. Bottomley. Fees: from 7s. 6d. per session. Group courses arranged for Students engaged in Chemical Industries. Session commences Sept. 17th. Prospectuses of various Classes free on application to the Head Master.

City of Leeds Higher Education Department.—Courses of Evening Classes have been arranged for the Minor Examination of the Pharmaceutical Society, in which the whole Syllabus will be covered in three Winter Sessions. Chemistry: Mr. S. Parrish, B.Sc., A.R.C.S., Chief Lecturer in Chemistry, Central High School. Botany: Mr. Norman Walker, Assistant Lecturer in Botany, Leeds University. Pharmaceutics: Mr. J. H. Gough, Ph.C., F.C.S., Demonstrator in Materia Medica and Pharmacy, Leeds University. Full particulars from Mr. James Graham, Secretary for Higher Education, Education Offices, Leeds.

The Municipal School of Technology, Sackville Street, Manchester.—This fine building occupies an area of upwards of 6800 square yards, and is six floors in height. Its equipment, which is nearly complete, is on a scale of great magnitude. It comprises laboratories and workshops for Mechanical, Electrical, Sanitary and Hydraulic Engineering, for the Textile industries, for Photography, Collotype and Photo-mechanical processes, for the Letterpress and Lithographic industries, and for the industries included within the scope of Architecture. The provision for the teaching of Chemistry, as might be expected in a district where the Chemical industries are important, is of an exceptionally complete character. It comprises, in addition to ample accommodation for pure Chemistry, laboratories for Metallurgy, Brewing, Bleaching, Dyeing and Printing, Paper-making, and Electro-chemistry. The Bleaching, Dyeing, Printing and Finishing, and the Paper-making industries are in addition extensively equipped in a separate building with machinery and appliances on an industrial scale. A Brew-house is also equipped on the low gravity principle, with a plant of four bushel capacity. The School is now established as the Faculty of Technology in the University of Manchester, and students of the School fulfilling the conditions can now proceed to the Degrees of Bachelor and Master of Technical Science (B.Sc. and M.Sc. Tech.).

Wolverhampton Municipal Science and Technical School.—Inorganic and Organic Chemistry, Mr. W. Whitehouse, F.C.S.; Physics, Messrs. W. Whitehouse and A. T. Harrison, B.Sc.; Botany, Mr. Sidney Phillips, Ph.C. Day Classes in Chemistry, and Evening Classes in Chemistry, Physics, Botany, French, &c. Special arrangements are made for the requirements of Pharmaceutical and Medical Students. Session commences Monday, Sept. 17th. For other particulars and programme, apply Mr. G. F. Chell, Registrar.

# SESSION 1906-7.

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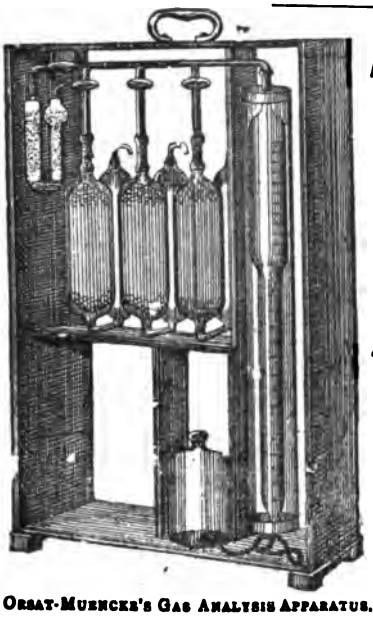

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THE

# CHEMICAL NEWS

AND

## JOURNAL OF PHYSICAL SCIENCE

Edited by Sir Wm. Crookes, F.R.S.] (WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE") [Established Sixty-three Years.

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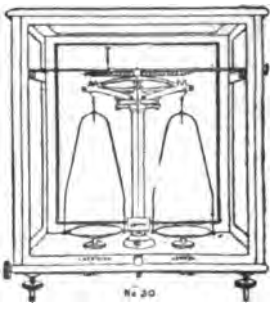

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**DIAMONDS.**

A Lecture delivered before the British Association at Kimberley.

By SIR WILLIAM CROOKES,

Hon. D.Sc. (Oxford, Dublin, and Cape of Good Hope), F.R.S.

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THE CHEMICAL NEWS.

Vol. XCIV., No. 2442.

## ON RADIO-ACTIVITY AND RADIUM.*

By Sir WILLIAM CROOKES, D.Sc., F.R.S.

The speaker commenced by saying that so little was known about this subject that it was the duty of every worker to throw his knowledge into the common pot, to be boiled down and assimilated into something useful. He asked what was the origin of the heat given out by radium, and, supplying the answer himself, said it must be due mainly to the sudden arrest of the discharged α-particles. He pictured to himself an atom of radium as a stellar system of electrons and groups of electrons revolving round each other with velocities of the order of that of light; those on the extreme outer surface of the system being more loosely held are liable to be thrown off tangentially, when they travel in straight lines, with scarcely diminished speed. The β-particles, or electrons, are so small that they penetrate solid bodies to a considerable depth, but the α-particles are large, and in spite of their enormous velocity cannot penetrate more than a few centimetres of air, and are stopped by a thin aluminium screen. It is evident that the sudden arrest of the atoms moving with such velocity would evolve heat. Indeed, in the spinthariscope we see the effect in the splash of light; and in other circumstances the surrounding medium becomes warm. He had an idea—it had scarcely got as far as a hypothesis yet—that a molecule of radium locked up in a rock mass and compressed in the interior of the earth would not throw off particles, but would remain in a state of suspended animation. He had tried experiments with pitchblende, and the results showed that ¼ inch of the powdered mineral, compressed in a short lead tube, had exactly the same action on a photographic plate as 2 inches of the same powder in a longer tube. This is an additional argument in favour of the action being one of surface only.

The speaker concluded by describing an experiment in in which 23½ m.grms. of radium bromide, enclosed tightly in a brass box and embedded in ice, failed to show any melting effect in forty-eight hours.

## RADIO-ACTIVITY.†

At a meeting of the two divisions of Section A, on August 6th, a discussion took place on "Radio-activity and the Internal Structure of the Earth." It was opened by the Hon. R. J. Strutt, and a discussion ensued, in which Professor Milne, Professor Gregory, Sir William Crookes, Sir George Darwin, Sir W. Ramsay, Mr. Oldham, Professor Lamb, and Mr. Soddy took part, Mr. Strutt briefly replying to the whole. The discussion has attracted much interest, and many letters from leading men of science have appeared subsequently in *The Times* on the subject of radium. In view of the importance of the theoretical problems thus advanced, a reprint of all the important letters which have appeared will be of present and future interest. We preface them by an abstract of the proceedings at the British Association (Section A) meeting, as far as they bear on the physical and chemical problems centred in radium.

The Hon. R. J. Strutt said that it had long been supposed that the internal heat of the earth was merely a remnant of the heat generated by contraction of a primeval nebula. This theory appeared until lately the only possible one; it was open, however, to the objection that in that case the time which could have elapsed since the earth was red-hot became very short—much shorter, in fact, than the requirements of geology could easily admit. Some kind of "modus vivendi" had been reached between geologists and physicists on this matter. It may be doubted, however, whether the result of the controversy was really satisfactory to either party. Two years ago the suggestion was made by several writers that there might be enough radium in the earth to account for the internal heat. Rutherford calculated from some data given by Elster and Geitel that if the earth contained throughout its volume as much radium as a sample of clay examined by them, the temperature gradient at the surface would be about accounted for. I have recently examined a large number of rocks, both igneous and sedimentary, and have been led to the conclusion that there is very much more radium in all of them than would be needed to maintain the earth's internal heat if the earth were constituted of rock throughout. From this I conclude that the interior of the globe does not contain radium, and that in all probability its composition is quite different in other respects also from that of surface materials. My data for the quantity of radium in rock point to a thickness of at most forty-five miles for the earth's rocky crust. Such a thickness of rock would contain amply sufficient radium to maintain the earth's temperature gradient. Calculation on these premises, on the assumption that the thermal conductivity of rock is not much affected by change of temperature, proves that the internal temperature at the bottom of the crust (forty-five miles down) would be about 1500° C. The inside nucleus, heated by the crust of radium-containing material, must be at this uniform temperature throughout, just as a loaf of bread, which has been in an oven long enough, takes up a steady temperature equal to that of the walls of the oven. I have found in discussing the subject with scientific friends who are not concerned with the detailed development of radio-activity that one objection is specially felt. It is urged that a gramme of radium diffused through an enormous volume of rock may not develop nearly so much heat as it would do if concentrated. In answer to this it may be replied that—(1) there is no reasonable doubt that the heat development of radium is intimately associated with its peculiar electrical behaviour. Indeed, according to Rutherford's data, it can be quantitatively accounted for as the kinetic energy of the α-particles emitted. The rate of emission of α-particles by pitchblende, as measured by ionisation, is exactly what might be expected on the view that the radium atoms contained in the mineral are as energetic as they would be if they were all collected together. (2) Direct measurements made by Pegram on uranium and thorium have shown that these feebly active elements give about the amount of heat which their activity would lead one to expect. I think that these considerations leave no reasonable ground for the objection above mentioned.

Sir William Crookes made some remarks, which are reproduced in full in preceding column.

Sir W. Ramsay referred to an experiment which pointed to a different conclusion from that drawn by Sir William Crookes. He had inserted in the hollow bulb of a thermometer an extremely small portion of the emanation of radium, and the readings of the thermometer so treated could be compared with those of another thermometer which had no radium. The readings of the treated thermometer remained for three weeks some three-quarters of a degree higher than those of the other.

## RADIUM.

The following letters have appeared in *The Times*:—

(August 9, 1906).

Sir,—In your yesterday's issue, under heading "British Association," I read, "In the Mathematical and Physical Section, a discussion was opened by Professor Soddy on

* Remarks made during the discussion on "Radio-activity and the Internal Structure of the Earth," at the meeting of the British Association, Section A, August 6th. (See "Radio-activity," above).

† British Association, York Meeting, 1906.

the possible transmutation of the elements. . . . The statement that the production of helium from radium has established the fact of the gradual evolution of one element into others was not seriously questioned."

I wish to remark that an isolated experimental discovery by Sir William Ramsay and Professor Soddy, brilliantly interesting as it is, and solidly instructive as it is towards the theory of radium, suggests nothing more towards any modification of the atomic doctrine proposed some 2500 years ago by Democritus and universally adopted by chemists and other philosophers in the Nineteenth Century, than does Ramsay's original discovery of helium as an emanation from the mineral clevite. The obvious conclusion from the two discoveries is that clevite and radium both contain helium.

I cannot refer, thus publicly, to discussions on radium in the meeting of the British Association which commenced last Wednesday in York without protesting against the hypothesis that the heat of the sun or earth, or other bodies in the universe is due to radium. I believe it is mainly due to gravitation; and I believe that the experimental results on which the radium hypothesis has been built give no foundation on which it can rest.—I remain yours faithfully,

KELVIN.

Aix les Bains, Aug. 5.

---

(August 10, 1906).

SIR,—I venture to think that the thanks of the public are due to Lord Kelvin for his timely and outspoken protest against the conclusion being drawn, from the evidence at present before us, that it is proved that there is a "gradual evolution of one element into others." No one has yet handled "radium" in such quantity or in such manner that we can say what it is precisely. That helium can be obtained from "radium" appears to be proved; but no proof has yet been given that it is not merely contained in it. As I remarked at York last week, physicists are strangely innocent workers; formulæ and fashion appear to exercise an all-potent influence over them.

There was a time when the expression "scientific caution" meant the highest degree of caution, and it was supposed to be the attribute of workers in science. Workers in the radium school appear to have cast caution to the winds, and to have substituted pure imagination for it. Among ourselves, we should always be at liberty to postulate the most crack-brained of hypotheses, to dream the wildest of dreams, as a means of guiding inquiry; but we should not court popularity on such a basis. By so doing we lose all claim to guide public opinion.—I am, Sirs, yours obediently,

HENRY E. ARMSTRONG.

---

(August 15, 1906).

SIR,—Lord Kelvin's letter in your issue of August 9 will, of course, receive respectful attention, and even in this holiday time the public may expect some reply. The fact that physicists have been unable to carry their veteran leader with them in some recent developments has been regretfully known—it is admitted, for instance, on the last page of the third edition of my "Romanes Lecture," as issued by the Clarendon Press—but it is also known that his brilliantly original mind has not always submitted patiently to the task of assimilating the work of others by the process of reading, and our hope has been that before long he would find time and inclination to look into the evidence more fully.

The evidence for the generation of helium may be briefly summarised thus:—Rutherford measured the magnetic deflexion of the $\alpha$-rays, or positively charged particles shot off by radium emanation at a certain stage of its disintegration (for it does disintegrate, it is not permanent), and inferred that the mass of each particle was comparable with twice that of an atom of hydrogen; consequently that the projected particles were material, and that the projected matter, if it were any single known substance, must be either hydrogen or helium, and most likely helium. Ramsay and Soddy then enclosed some of the emanation in a vacuum tube, and examined its spectrum. There was no sign of helium at first—as there would have been had it been merely an ingredient in a mixture—but the helium spectrum gradually made its appearance, in the course of a day or two, at approximately the rate to be expected on the disintegration hypothesis. The loss of much activity by radium when its emanation is removed from it and the gradual return of radio-activity when time is allowed for fresh emanation to be formed, are also facts to be remembered. The rest of the evidence for the slow disintegration of atoms is of a less direct kind, but it is voluminous and varied, and seems to me extremely weighty.

Lord Kelvin's maintained opinion as to the heat of the earth and of the sun is of great interest. He and Helmholtz have both shown conclusively that if the sun is contracting at a certain slow rate—a yard or two per month, if I remember right, too small an amount to be detected as yet—gravitational energy is quite sufficient to account for the whole of its heat emission. The only question is whether or not the sun is actually shrinking at the prescribed rate. It is an efficient cause, and it may be the only cause in operation; or it may be supplemented by another, namely, by the conversion into ethereal radiation of some portion of the presumably vast store of intra-atomic energy, perhaps by a process so direct as partially to evade the intermediate stage of the random molecular motion called heat. For it is a suggestive question to ask why suns do not exceed a certain limit of size and temperature. Is it possible that under excessive conditions atomic disintegration begins to set in at more than the spontaneous rate?

As soon as solar shrinkage can be measured we shall know the proportion in which the two causes, the gravitational and the atomic, contribute to the total result.

As for the case of the earth: if the interior is hot at all—and about that there appears to be no doubt—heat must be flowing up through the crust: and this is the process utilised by Lord Kelvin in his calculation. It will be remembered that when he conceived the idea of applying this criterion to make a rough preliminary estimate of the lapse of time since the earth was molten, he expressly guarded his deduction by saying "provided no other process than conduction of heat occurs"; a proviso which clearly allowed for the now discovered generation of some heat *in situ* from a then unknown and quite unsuspected source.

I see a characteristic comment by Professor Armstrong in your issue of August 10. He and a few other chemists have before now shown themselves scornful of chemical results obtained by physical means; but they manage to absorb these results in the end. Chemists have an instinct of their own for arriving at such doctrines as the constitution of organic compounds and other admirable discoveries; and though occasionally it may happen that their methods of reasoning seem to us odd and unconvincing, they are ready, and even eager, to retort that ours are forced and unintelligible. But wisdom is justified of her children.—I am, Sirs, yours faithfully,

OLIVER LODGE.

The Hermitage, Bletchingley, Surrey.

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(August 15, 1906).

SIR,—As Lord Kelvin in his letter of August 9 referred unfavourably to the views which I expressed in opening a discussion in Section A of the British Association at York on the internal heat of the earth, I hope it may not be improper for me to draw attention to the other side of those questions which he raises. First, as to the production of helium from radium. Lord Kelvin seems to consider that the experimental results on this subject prove nothing more than that helium is an original constituent of radium. This view does explain the fundamental fact, independently

vouched for by Ramsay and Soddy, by Himstedt and Meyer, and by Curie, that the supply of helium obtainable from radium is constantly renewed. If all helium is removed from a sample of radium it is found that after an interval a further supply can be extracted. This can only mean that helium has been generated since the last extraction.

Lord Kelvin does not enter into any detailed criticism of the view that the internal heat of the earth is due to radium. He merely describes it as a hypothesis. I cannot think this description a fair one. I have attempted to show by quantitative experiment that the amount of radium in the earth's crust is so large that we are compelled to suppose that crust very thin in order to explain why the heat conducted out of the interior of the earth is not even greater than we find it to be by observation. I believe that Lord Kelvin does not refuse to accept my experimental results. Indeed, he has been so kind as to write to me very appreciatively of them. What, then, is his objection? It is true that gravitational condensation is a cause which must have once heated the earth. But we have no reason for supposing that any of the heat so generated still remains. If we did suppose so we should be face to face with the question, What becomes of the heat generated by the radium admitted to be present in the earth?

R. J. Strutt.

40, Portman Square, W.

(To be continued).

## SIZING PAPER WITH VISCOSE.*

By CLAYTON BEADLE.

In discussing this subjcct I feel compelled to say a few words in explanation of the subject chosen, namely, the use of viscose for paper sizing, which is still the subject ot a patent. I feel that I must discuss the matter only in the light of the information which has already been made known, as I should not feel justified in going further than this. What I am about to describe and discuss is based on data already disclosed in connection with viscose.

I shall carefully omit all reference to the question of theory and deal as far as possible with that of fact, and confine myself to remarks on the manufacture and use of viscose in its application to paper.

The first stage of the manufacture of viscose is the preparation of what is called alkali-cellulose, or what was formerly known as Mercerised-cellulose, from the name of its inventor.

An alkali-cellulose adapted to the use of papermakers has approximately the following composition:—

| | |
|---|---|
| Cellulose.. .. | 25 per cent. |
| Alkali .. .. | (NaOH) 15 per cent. |
| Water .. .. | 60 per cent. |

This is generally prepared by taking, say, 100 lbs. of well-beaten pulp containing 50 per cent moisture, and grinding the same in edge-runners. Whilst the grinding action is going on, a stream of caustic soda solution is added at 70° Tw. and equal in weight to the weight of the wet pulp taken. The alkali should be added in a slow stream; if added too quickly the stuff gets greasy and the stones are liable to skid, but if added slowly the alkali is taken up by the cellulose; the whole operation takes about three-quarters of an hour. The so-called alkali-cellulose consists of fibres swollen by absorption of alkali and water, and when cotton or linen pulp is used is not unlike snow in appearance. This alkali-cellulose should be stored in a cool place, the temperature not exceeding 60° F., in air-tight tubs kept from contact with the air. If the air is allowed to get in contact with the alkali-cellulose the carbonic acid of the air combines with the alkali, producing carbonate of soda and rendering the cellulose no longer susceptible to attack of carbon bisulphide. I made it a regular practice to examine different batches of alkali cellulose, the results of which were recorded. With care, great regularity can be ensured. A simple method of examination is to weigh out 10 grms. of alkali-cellulose, taking care that an average sample is selected. This is added to about 150 c.c. hot water, agitated for a few minutes, and filtered through muslin into a litre flask, and washed with hot water until free from alkali. The filtrate is cooled, made up to 1000 c.c. An aliquot portion is titrated after further dilution with recently boiled and rapidly cooled distilled water in presence of phenolphthalein until red colour is just discharged, then to neutural tint with methyl-orange. The residue on the filter is dried at 105° C. Weight + 7 per cent, equals air-dry weight of cotton or linen cellulose, or if from wood pulp one-ninth is added for air-dryness.

On account of the liability of alkali-cellulose to be affected by heat it has to be stored in the cool; the effect of heat is to bring about a molecular change in the alkali-cellulose, rendering it of less service in the sizing of paper, as will be demonstrated hereafter. For all ordinary purposes alkali-cellulose can be stored for several weeks or even months in the temperature above given, but if brought into a temperature such as prevails in the summer months it would last only a few days.

The word "crumbs" is used in England to designate alkali-cellulose, in consequence of the close resemblance of alkali-cellulose as prepared for papermaking to ordinary bread crumbs.

The alkali-cellulose has next to be put into a revolving barrel or churn, which is about three-fourths filled, and carbon bisulphide equal to one-tenth the weight of the alkali-cellulose is then added, and the churn revolved for fifteen minutes to thoroughly mix the ingredients; it is then allowed to stand. It is best to do this at a uniform temperature, say at 70° F.; at this temperature the reaction takes about two hours. The carbon bisulphide combines with the alkali-cellulose to form a compound which is soluble in water, the colour changes from white to brilliant yellow, and darkens to a brown shade if allowed to remain long before dissolving. In mass reactions even in 1 cwt. batches one has to guard against sudden rise of temperature. Little or no rise is noticed when the initial temperature is in the neighbourhood of 60° F., but at 75° to 80° the temperature may rise, due to the rapidity of the reaction, to such a final temperature as to bring about a complete reversion of viscose, producing again insoluble cellulose as a large ball or lump in centre where the temperature has reached its highest point.

The yellow mass, which has somewhat the consistency and appearance of fine particles of butter, is discharged from drum and agitated with one and a-half times its weight of water, giving rise to a yellow thick viscous solution to which the name of "Viscose" has been given. This solution contains 10 per cent of cellulose. In course of time the solution darkens in colour, changing from that of golden syrup to ordinary molasses.

I should like to point out the importance ot making the viscose under the most favourable conditions, as so much depends upon this as to whether the result is good or not. This remark applies, of course, to all applications of viscose, each application requiring viscose manufactured in a particular manner. First of all I would point out that the time the alkali-cellulose is kept before the carbon bisulphide treatment, alters the viscosity of the solution; thus, if it is kept a long time, the viscosity of the solution produced from the same is lowered; if, on the other hand, the solution is made up from fresh crumbs, it has its maximum viscosity; but alkali-cellulose can be stored for weeks in a refrigerator without bringing about very much change in the viscosity of the solution produced from the same. The molecular change can, therefore, be promoted by heat or arrested by refrigeration; the exact change or rate of change being dependent upon the temperature. At a higher or critical temperature the change is so rapid as to break down the cellulose to a useless product in a few

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minutes. At the freezing point (or below) the change is practically arrested. One could draw up a curve to illustrate the rate of change at different temperatures which would be highly instructive to those engaged in viscose making.

It follows then that if alkali-cellulose is stored in a hot place the resulting solution is comparatively thin; even if the alkali-cellulose is kept for only a couple of days in a warm room the solution would be very much thinner and less viscous. It is possible, by altering the temperature, to very much control the condition of the solution to suit various requirements. It cannot be said, however, that time and temperature are altogether interchangeable factors, as there are conditions of solution brought about by storing at moderate temperatures which cannot exactly be imitated by elevating the temperature for a short period. The slow process of ageing is almost always preferable.

Then, again, the amount of alkali in comparison with that of cellulose present, very much influences the viscosity of the resulting solution; within limits, the higher the alkali the lower the viscosity, and *vice versa*. The alkali can be lowered to say 12 per cent on the weight of alkali-cellulose or 50 per cent on cellulose, but for most ordinary purposes it is not advisable to do this, because there is a danger of leaving a considerable proportion of the fibres still unacted upon. There is, therefore, no economy in sparing the amount of alkali if such results in certain of the fibres being left unacted upon. The composition given above is about the most useful all-round one. The viscosity of the solution can be lowered by the addition of caustic soda direct to the viscose solution. This, however, is not to be recommended for paper sizing.

The effect produced by the viscose in strengthening and hardening the paper is more dependent upon viscosity of the solution than upon its percentage strength in cellulose. This is a cardinal point to be remembered. The higher the viscosity the greater the strength-giving effect. If, given two solutions of equal strength (say 10 per cent), one prepared to be very viscous, and the other very thin or non-viscous, it is quite possible that the former may have five times the strength-giving effect of the latter. It would be necessary, therefore, to use five of the latter to one of the former. The art, therefore, of preparing viscose for this purpose is to do so in such a way as to give its maximum strength-giving and hardening effect, so that the desired result may be brought about by the use of the minimum quantity of viscose. It is, however, necessary to distinguish between a "ropiness" due to untreated or partially treated cellulose and the proper viscosity of the solution.

Viscose has a property of coagulating or becoming insoluble. The solution in time hardens to a jelly, forming again insoluble cellulose, but in a hydrated condition. If, however, the solution is extremely dilute, as it is in an ordinary paper-makers' beater, and agitation is going on at the same time as coagulating is taking place, instead of homogeneous jelly being formed, a flocculent precipitate of cellulose is produced, which, in contact with the pulp on the paper machine can be made to agglomerate into one continuous mass, and give strength to the paper by glueing the fibres together. The art of viscose sizing is to bring this change about so as to give the maximum benefit to the paper. It is advisable to use the viscose solution within a short period of the time of manufacture; it will not keep indefinitely, and for this reason it should be by preference made in the paper mill where it is to be used. The effect produced is not unlike that due to prolonged beating with dull tackle, whereby some of the fibre is munched up into a gelatinous mass of hydrate, which has the power of acting as an adhesive, and glues the fibres together when made into pulp.

When a dilute solution of viscose is added to the paper-maker's beater precipitation does not take place quickly, particularly with freshly made viscose. It is necessary, therefore, to add some substance which will bring about the precipitation of the cellulose, but in such a manner as to preserve its flocculent sticky condition. Ordinary mineral acids will precipitate it at once, but destroy its good qualities; alum, also, is too acid a substance, and in a measure has the same effect as mineral acids. Something is needed to precipitate the cellulose in a more gentle fashion; this can be accomplished by the addition of magnesium sulphate or zinc sulphate. These salts decompose the soluble compound, leaving the cellulose suspended in contact with the fibres and the pulp neutral.

In order to appreciate the influence of various slight modifications in the *modus operandi* of working I will give a few details of one or two trials which I have conducted. I would point out that I have conducted somewhere about two hundred viscose paper-sizing trials, some purely laboratory investigations and others done on a large scale; in nearly all cases the quantities, details, temperature, time, &c., were carefully noted, and I feel, therefore, in regard to any conclusions that I may have arrived at, that I speak with a certain amount of authority as having had a fairly extensive experience.

*No.* 15. 10% *P.W.L. Crumbs.* (Composition as above stated).
February 13, 1897.

Made up into viscose as follows:—

5% solution made by adding 50 parts water to 50 parts of 10% solution.
6¼% solution is made by adding 26 parts water to 50 parts of 10% solution.
8% solution is made by adding 12·5 parts water to 50 parts of 10% solution.

*Paper Trial No.* 16. February 16, 1897.
(Beaten February 4, 1897).

800 parts 5% mechanical aspen.
7200 „ of water.
10 „ 5% P.W.L. viscose.
In 10 minutes 12 parts 5% zinc sulphate.
In 5 „ 8 „ 5% resin solution.
In 5 „ 3 „ 5% potash alum.
In 5 „ made into paper.

*Paper Trial No.* 17. February 16, 1897.
(Beaten February 4, 1897).

800 parts 5% mechanical aspen.
7200 „ of water.
10 „ 6¼% P.L.W. viscose.
In 10 minutes 15 parts 5% zinc sulphate.
In 5 „ 8 „ 5% resin.
In 5 „ 30 „ 5% potash alum.
In 5 „ made into paper.

*Paper Trial No.* 18. February 16, 1897.
(Beaten February 4, 1897).

800 parts 5% mechanical wood (aspen).
7200 „ of water.
10 „ 8% P.L.W. viscose.
In 10 minutes 15 parts of 5% zinc sulphate.
In 5 „ 8 „ 5% resin.
In 5 „ 30 „ 5% potash alum.
In 5 „ made into paper.

*Paper Trial No.* 19. February 17, 1897.
(Beaten February 4, 1897).

500 parts 5% mechanical aspen.
7200 „ of water.
10 „ of 10% P.L.W. viscose.
In 15 minutes 16 parts of 5% zinc sulphate.
In 5 „ 8 „ 5% resin.
In 5 „ 3 „ 5% potash alum.
In 10 „ made into paper.

*Paper Trial, No.* 20.

As above, but containing no viscose, &c.

Below are the strength tests done upon Samples 16—20, selecting samples of 5/1000 inches in thickness; the strength is expressed in lbs. per strip of 1 inch width :—

| No. | 16. | 17. | 18. | 19. | 20. |
|---|---|---|---|---|---|
| | 5·9 | 5·7 | 4·4 | 5·2 | 2·9 |
| | 4·2 | 6·2 | 4·0 | 4·9 | 2·8 |
| | 4·1 | 5·8 | 4·4 | 5·2 | 3·2 |
| | 4·3 | 3·5 | 4·0 | 4·9 | 2·7 |
| | 5·4 | 3·5 | 4·0 | 4·7 | 3·0 |
| | 6·0 | 3·8 | 4·2 | 4·7 | 2·5 |
| | 2·8 | 4·5 | 4·3 | 5·3 | 2·0 |
| | 5·4 | 4·5 | 4·4 | 4·4 | 1·9 |
| | 3·4 | 4·8 | | | 3·7 |
| | 4·2 | 3·7 | | | 2·0 |
| | | | | | 2·3 |
| | | | | | 2·0 |
| No. of tests .. .. | 10 | 10 | 8 | 8 | 12 |
| Mean strength .. | 4·57 | 4·60 | 4·22 | 4·91 | 2·60 |
| Reducing No. 20 to 100 for comparison | 175 | 177 | 162 | 188 | 100 |

The last line shows the gain in strength due to the added viscose, when 100 is deducted from each.

*Paper Trial No.* 28. February 24, 1897.

800 parts of 5% mechanical aspen beaten Feb. 4, 1897.
7200 „ water.
Made into paper.

Summary of strength test .. $\frac{39·2}{2·02} = 19·04$.

*Paper Trial No.* 29. February 24, 1897.

800 parts of 5% mechanical aspen beaten Feb. 4, 1897.
7200 „ water.
8 „ 5% resin.
3 „ 5% potash alum.
Made into paper.

Summary of strength test .. $\frac{44·5}{2·13} = 20·9$

*Paper Trial No.* 30. February 24, 1907.

800 parts of 5% mechanical aspen beaten Feb. 4, 1897.
7200 „ water.
5 „ 8% P.L.W. viscose.

(Average of five mixings alkali cellulose about 10 days old and stored out of doors). Viscose about 12 hours old.

In 15 minutes 12 parts of 5% zinc sulphate.
In 5 „ 8 „ 5% resin.
In 5 „ 30 „ 5% potash alum.
In 5 „ made into paper.

Sample of the above viscose gave 8·90% of bone-dry cellulose.

Summary of strength test .. $\frac{65·7}{2·14} = 30·7$

No. 29 : No. 30 :: 100 : 148
No. 28 : No. 30 :: 100 : 153

*Paper Trial No.* 31. February 25, 1897.

800 parts of 5% mechanical aspen beaten 1 hour before.
7200 „ water.

Summary of strength test .. $\frac{65·0}{1·92} = 33·8$

*Paper Trial No.* 32. February 25, 1897.

800 parts of 5% mech. aspen beaten about 1¼ hrs. before.
7200 „ water.
8 „ 5% resin.
3 „ potash alum.

Summary of strength test .. $\frac{67·1}{1·85} = 36·2$

*Paper Trial No.* 33. February 25, 1897.

800 parts of 5% mech. aspen beaten about 2¼ hrs. before.
7200 „ water.
5 „ 8% P.L.W. crumbs about 12 days old.
Viscose average three mixings about 12 hours old.
Made February 24, 1897.

Sample of the above viscose gave 8·32% of bone-dry cellulose.

Summary of strength test .. $\frac{70·9}{1·67} = 42·4$

No. 31 : No. 33 :: 100 : 125
No. 32 : No. 33 :: 100 : 117

*Paper Trial No.* 34. February 26, 1897.

800 parts of 5% mechanical aspen beaten Feb. 25, 1897.
7200 „ water.

Summary of strength test .. $\frac{64·7}{2·15} = 30·1$.

*Paper Trial No.* 35. February 26, 1897.

800 parts of 5% mechanical aspen beaten Feb. 25, 1897.
7200 „ water.
8 „ 5% resin.
30 „ 5% potash alum.

Summary of strength test .. $\frac{74·8}{2·17} = 34·4$.

*Paper Trial No.* 36. February 26, 1897.

800 parts of 5% mechanical aspen.
7200 „ water.
5 „ 8% viscose.

Made from P.L.W. crumbs about 14 days old. Made into viscose Feb. 25, 1897. Average of three raisings.

In 15 minutes 20 parts of 5% zinc sulphate.
In 5 „ 8 „ 5% resin.
In 5 „ 3 „ 5% potash alum.

Sample of the above viscose gave 8·12% of cellulose.

Summary of strength test .. $\frac{112·1}{2·4} = 46·7$

Comparison of strength tests of Nos. 34—36 :—

No. 34 : No. 35 :: 100 : 114
No. 35 : No. 36 :: 100 : 136
No. 34 : No. 36 :: 100 : 155

*Added Cellulose.*

In viscose-engine sizing, taking experiments Nos 16—20, also Nos. 34—37 :—

| Viscose equal to added cellulose on paper. | Total added strength. | Equal to added strength for each 1% of added cellulose. |
|---|---|---|
| 1·00% | 54% | 54% |
| 1·25 | 75 | 59 |
| 1·62 | 77 | 47 |
| 2·50 | 88 | 35 |

Tables 15 to 30 give details of various viscose trials; No. 15 shows the way the different strengths of viscose solution were made up for the purposes of trials. The object of these trials was to determine the strength giving effect of viscose on very weak material, such as ordinary newspaper, which is composed for the most part of mechanical wood; it will be noticed that rosin size is used in most cases equal to 1 per cent on the weight of the paper.

Trial No. 20 was made without the addition of rosin or viscose for the purposes of comparison. In each case the first chemical ingredient was added ten or fifteen minutes after the viscose, then five minutes elapsed before the addition of rosin, and another five minutes before the addition of alum, and in most cases five minutes after this the pulp was made up into paper. The strength tests were done as follows :—

Five to ten strips of 1 inch wide by 4 inches long were cut and tested on a "Marshall" tester; each test was noted, as also the thickness of pieces, in order that corrections should be made in the strength test for any variation in the thickness of the sheet.

The strength tests of Nos. 16 to 20 are given in detail. The figures at the bottom show the relative strengths of the various mixtures when the waterleaf No. 20 is reduced to 100, showing the great gain on the addition of viscose.

Passing to trials Nos. 34 to 36, No. 34 is waterleaf alone, No. 35 is the same with the addition of 1 per cent of rosin and the necessary alum, No. 36 is the same but with the addition of viscose, the details of the manufacture of which are given, and the necessary amount of zinc sulphate required for the precipitation. Above are given the relative strengths of the foregoing trials when the waterleaf is reduced to 100. It should be noticed that the one containing 1 per cent of rosin is 14 per cent stronger than the waterleaf. This is in contradiction, I believe, to statements made by Hertzberg and Hofmann to the effect that rosin decreases the strength of paper.

In a recent lecture delivered in London I gave the result of all the determinations I had made for strength of paper with and without rosin. My conclusion was, and of this I have no doubt, that very weak papers, such as those composed almost entirely of mechanical wood, are increased in strength by the addition of rosin, whereas papers consisting of very strong fibres decrease. Papers such as those given in the trials herein described are all increased in strength by the addition of rosin.

It will be noticed from Trial No. 36 that the addition of viscose has added to the strength of the paper in question to the extent of 36 per cent over and above the strength of the rosin sized paper containing no viscose, and 55 per cent over and above the waterleaf paper.

Turning briefly to the Trials Nos. 28 to 30, it will be noticed that No. 29 (containing no viscose) is much weaker than No. 30 (with viscose); the addition of viscose, as in this case, added to the strength of the paper to the extent of 48 per cent, or showing a total increase of strength above waterleaf of 53 per cent. Turning back to the summary embodying the results of Nos. 16 to 20 and 34 to 36, it will be noticed that the papers in question show an average increase in strength of 54 per cent for the addition of 1 per cent of cellulose as viscose. When 1·25 per cent is added the total increase in strength is 75 per cent, making an increase in strength on the waterleaf of 59 per cent for each 1 per cent, of added viscose. When we come to the addition of 1·62 per cent of cellulose as viscose, the total increase is 77 per cent, showing a very slight addition on the 1·25 per cent, and, consequently, a very much lower figure for each 1 per cent of added viscose (viz., 47 per cent). When 2·5 per cent cellulose as viscose is added, being double the 1·25 per cent, the strength is only increased from 75 per cent to 85 per cent, and the increase in strength for each 1 per cent of added viscose drops down to 35 per cent.

The various trials that I have made have led me to the conclusion that there is a great distinction between the percentage rate of increase of strength of the paper and the absolute increase in strength of the paper where one is dealing with the question of added cellulose or gelatin.

It is possible from the trials cited, which were conducted in a manner to observe any slight difference that might arise, to arrive at certain definite conclusions:—

First of all, the maximum strength for 1 per cent of added cellulose in the form of viscose is imparted to the paper when viscose of the maximum viscosity is used. The maximum effect for each 1 per cent of cellulose is obtained when small amounts are added (*i.e.*, 1 per cent or less); thus 2 per cent would not exert double the effect upon the paper that 1 per cent does, nor would 4 per cent exert double the effect upon the paper that 2 per cent does.

There appears, furthermore, to be a limit to any increase of strength due to the addition of viscose; for example, a point may be reached in one paper on the addition of 5 per cent of cellulose, and in another on the addition of 10 per cent, beyond which the additions of further quantities of cellulose as viscose would give no increase of strength.

I would point out, in conclusion, that the effect of viscose sizing is somewhat similar to the effect of excessive or prolonged beating in the Hollanders. In the case of prolonged beating the fibres are more or less hydrated, and a certain amount of cellulose is formed which causes the stuff to work wet, and gives to it greater strength and hardness. In the case of viscose sizing, instead of affecting the fibres themselves, the cellulose hydrate is added or precipitated, giving to the pulp somewhat the same properties as if the beating had been prolonged.

A proper appreciation of the factors which go to produce viscose of suitable properties for paper sizing is indispensable. It is no difficult matter to produce viscose that will be useless for the purpose. On the other hand, with a careful study of the conditions and proper control in the factory the best results can be got with much smaller quantities than is commonly supposed. This applies with equal force to sizing of webbing, of which I have had considerable experience. I no not wish it to be supposed that this article would give sufficient information to enable manufacturers to size with viscose. It will, however, I hope, put them on the right path and indicate to them the direction along which they must work to produce satisfactory results.

## THE DETERMINATION OF THE COMPOSITION OF NITROGEN IODIDE.

### A SHORT STUDY IN CHEMICAL HISTORY.

By F. D. CHATTAWAY.

IT is always interesting to follow the steps by which a definite conception of the composition and structure of a familiar compound has been gained. Sometimes we owe practically all our knowledge of a substance to its discoverer, but it more often happens that many minds and hands have added here a fact and there a theory until our present view of its nature and constitution has been built up.

It is seldom possible to allot to each investigator his precise share in the result, since it frequently happens that work on a different and apparently unrelated part of the subject throws unexpected light on the problem under consideration.

An interesting fragment of the history of chemistry is that which deals with the development of our present views of the nature of the so-called nitrogen iodide. Every schoolboy knows how easily this black explosive solid can be produced by mixing solutions of iodine and of ammonia.

It was first prepared by Bernard Courtois nearly a century ago, and a description of the curious new substance was included in a paper, read before the Institute on November 29th, 1813, in which he announced his discovery of the element iodine.

Courtois being too much occupied as a chemical manufacturer to continue the systematic investigation of the new element, this was undertaken by Gay-Lussac. In Gay-Lussac's laboratory and under his direction nitrogen iodide was first studied by Colin, who regarded it as a substitution derivative of ammonia of the composition $NI_3$. Gay-Lussac himself in his great memoir on iodine explained its formation on the assumption that it has this formula. The compound about this time was also investigated by Vauquelin and Davy, who agreed with Gay-Lussac in regarding it as analogous to nitrogen chloride; that is, as ammonia in which all the hydrogen had been replaced by iodine. Mitscherlich later was led to assign to it the formula NI from the observation that both it and ammonium chloride were produced by the action of iodine trichloride on ammonia. Serullas, who after an interval

of some years studied it, expressed no opinion as to its constitution, but concerned himself mainly with its reactions, including the action of acids, alkalis, and water on a product which he prepared by mixing solutions of iodine monochloride and ammonia. So far the formula $NI_3$ was generally accepted.

The fact that hydrogen is a constituent of the compound was next established by the work of Millon, Bineau, and Marchand. For this purpose various methods were employed, including Marchand's dangerous experiment of heating the dry substance with lead chromate. These chemists brought forward the formulæ $NHI_2$ or $NH_2I$. Bineau came to the conclusion that the former must be correct, since in the product he analysed the nitrogen and iodine were present in the ratio of one atom of nitrogen to two atoms of iodine. He obtained this incorrect ratio by decomposing his material with hydrogen sulphide, and noting that approximately two molecules of hydrochloric acid were formed to one of ammonia.

The study of the compound was continued by Gladstone and Bunsen, who about the same time published accounts of their researches. Although they described new reactions of the substance and variations in the methods of preparing it, they chiefly concerned themselves with attempts to determine its elementary composition. Gladstone came to the conclusion that one compound only could be obtained, whose composition he represented by the formula $NHI_2$. Bunsen, on the other hand, maintained that more than one distinct compound could be formed, and gave formulæ $NH_3.NI_3$ and $NH_3.4NI_3$ as the results of his two analyses. Gladstone, in a reply, pointed out that in the formation of nitrogen iodide by the interaction of iodine and ammonia, although nearly half the iodine appears as ammonium iodide, a trace of iodate is always found, a fact overlooked by Bunsen.

Schönbein, in a very interesting study of the action of the halogens on aqueous solutions of alkalis, also pointed out Bunsen's omission to observe the formation of iodate, and suggested that the reaction of iodine with ammonia was completely analogous to that of iodine with other alkalis, and that nitrogen iodide was formed by some decomposition of ammonium hypoiodite.

Many years later, Mallet analysed specimens of nitrogen iodide which, in purifying, he had subjected to the drastic treatment of long-continued washing with alcohol. From his results he concluded that a series of compounds existed, an inference which might be expected, inasmuch as the amount of decomposition depends on the conditions of such treatment.

The decomposition of nitrogen iodide by light, a most important fact in relation to its composition, was first noticed by Guyard, who proposed to use the substance for photometric purposes.

More recently, both Raschig and Szuhay discussed the work of previous chemists, but threw little fresh light on the subject. Lastly, Seliwanow has followed Schönbein, and sees in nitrogen iodide a derivative of hypoiodous acid. He attempted, but qualitatively only, to show that the formation of ammonium hypoiodite always preceded the precipitation of nitrogen iodide, and is one of the first products of the decomposition of the latter.

On reviewing all this work one is struck by the divergence in the analytical results of material obtained apparently by identical methods, as, for example, Gladstone and Bunsen's preparations of nitrogen iodide from saturated solutions of iodine and ammonia in absolute alcohol. It would appear either that different substances must have been obtained when the conditions were only slightly varied, or that the treatment to which the compound was subjected must have caused a partial decomposition which was not observed.

Moreover, not one of the chemists who studied the substance seems to have made a series of analyses to confirm the numbers on which his conclusions were based.

Further, the very frequent evolution of nitrogen in the various reactions described, although it generally escaped notice, even when observed, was neglected in the explanation suggested.

When some eleven years ago the study of nitrogen iodide was undertaken by the present writer, it appeared to be universally accepted that a number of distinct compounds existed, although the belief was based entirely upon discordant analytical results which, upon close examination, were clearly untrustworthy. Not only did the numbers obtained by different observers agree in very few cases, but even those of the same observer often differed widely. Further, in no single case was any evidence brought forward to show that the material analysed was pure, and in no case were any data given to justify the assumptions made regarding the reactions on which the analyses were based.

The confusion of the whole subject at that time may still be seen in the statements made regarding nitrogen iodide in some of the better known dictionaries and text-books.

Since that date, however, the composition of nitrogen iodide has been established beyond doubt, a fair amount of evidence has been brought forward in support of a constitutional formula, and its chief reactions and decompositions have been simply and quantitatively explained, while, further, the varied analytical results of previous workers have been shown to be due either to the partial decomposition of the compound by washing, leading to loss of ammonia, or to the loss of nitrogen caused by light, or to its partial decomposition by alcohol.

The first step in the elucidation of the tangle was a careful qualitative study of the conditions necessary for the preparation of pure nitrogen iodide and of those which obviously brought about its decomposition.

It was found especially that washing it with water, if this was at all prolonged, caused a liberation of iodine, that alcohol also very readily reacted with it, while even the diffused light of a laboratory falling upon it set free immediately both nitrogen and iodine. Obviously, therefore, light must be excluded in the purification and analysis of the compound, the use of alcohol in its preparation and purification should be avoided, and washing by water must only be carried to a point sufficient to remove free adhering ammonia.

A method of analysis had next to be sought which, while exact, could be expeditiously carried out and so admit of a very large number of analyses of specimens prepared by all known methods.

Such a simple and rapid process was found in the decomposition of the compound by sodium sulphite. When a solution of this substance reacts with nitrogen iodide suspended in water, a colourless acid solution is obtained containing only sodium sulphate, ammonium iodide, and free hydriodic acid, disregarding, of course, the distribution of the bases among the acids. This reaction, one of the very few where nitrogen iodide decomposes in one way only, was thoroughly investigated, and upon it a method of analysis was based.

Numbers of experiments showed that if light was excluded no nitrogen was disengaged in the free state, but that all of this element contained in the compound was obtained as ammonia, and that this result was not affected by the sulphite being added rapidly in excess or slowly drop by drop, or by the consequent non-appearance or appearance of free iodine in the liquid.

All the products formed in this reaction were estimated in a variety of independent ways, and the quantity of sulphite oxidised was found to be exactly double the amount equivalent to the hydriodic acid produced; that is, $Na_2SO_3$ produced HI.

This fact having been established, a simple method of analysis fulfilling all the conditions previously laid down was available. The solution resulting from the action of normal sodium sulphite upon nitrogen iodide is always found to be acid, since the amount of hydriodic acid produced is greater than that required to neutralise the ammonia simultaneously formed. This excess of acid can easily be estimated by standard alkali, and since sodium

sulphate is neutral and the total amount of hydriodic acid formed is accurately known from the quantity of sulphite used, the difference between the amount of hydriodic acid produced and the amount present as free acid represents the amount neutralised by the ammonia of which it is consequently a measure.

The actual analysis was carried out as follows :—A small quantity of nitrogen iodide was rapidly washed a few times on a filter-pump and suspended in water in a flask, light being excluded. A decinormal solution of sodium sulphite was then added slowly, drop by drop, until the iodine liberated towards the end of the reaction had disappeared, a little starch paste being used as indicator. Litmus was then added, and the free acid estimated by a decinormal solution of ammonia. The accuracy of these extremely simple titrations having been thoroughly established, a large number of analyses were made of specimens of nitrogen iodide prepared in every way known to yield it. It was found that the relation between the ammonia and hydriodic acid was absolutely invariable, two molecules of ammonia were always produced to three molecules of hydriodic acid. However nitrogen iodide is prepared, and whatever its condition, dry or moist, crystalline or amorphous, compact or finely divided, the relation between the ammonia and hydriodic acid is the same. In this way it was proved that in all reactions which are known to yield nitrogen iodide only one individual compound is formed, and that in its molecule two atoms of nitrogen are associated with three atoms of iodine.

It was further found that when nitrogen iodide decomposes under the influence of light it breaks up quantitatively into nitrogen and hydriodic acid. Consequently, its molecule must contain the same number of atoms of hydrogen as it does atoms of iodine. Since, therefore, in its molecule two atoms of nitrogen are associated with three atoms of iodine, and these again with three atoms of hydrogen, the simplest possible formula for nitrogen iodide is $N_2H_3I_3$.

That this formula correctly represents the composition of nitrogen iodide was further proved by a large number of analyses of weighed amounts of the pure dry substance prepared in different ways. The percentage of nitrogen and of iodine in every specimen agreed accurately with those required by the formula.

Moreover, all attempts to prepare similar bodies of a different composition in aqueous solution completely failed.

It may be taken, therefore, as a definitely proved fact that only one compound of the nature of nitrogen iodide has ever been prepared in aqueous solution, and that the composition of this is represented by the empirical formula $N_2H_3I_3$.

It is as certain as any inference can be that the discordant numbers of previously published analyses are due to three causes: unsuitable analytical methods, in which a variable amount of gaseous nitrogen was liberated and escaped estimation; decomposition by light during manipulation, and loss of the free nitrogen thus produced; and decomposition by prolonged washing, with liberation and consequent loss of ammonia. These adequately account for the varying results observed, because in every previously recorded analysis except a single one made by Bunsen (which agrees very nearly with the author's results) less than two atoms of nitrogen have been found associated with three atoms of iodine as would be the case if any or all of these causes were operative. Since single analysis only have, as a rule, been made of specimens prepared in different ways, chemists have concluded that they had in their hands distinct but similar substances of definite composition. Mixtures of any composition from nitrogen iodide, $N_2H_3I_3$, to pure iodine can, in fact, be obtained by washing nitrogen iodide continuously, and might be assumed in the absence of any evidence to the contary to be definite substances.

There is so far very little direct evidence from which to deduce a constitutional formula for the compound. It may be supposed with a fair degree of certainty that the two nitrogen atoms are linked together, and all the evidence we have goes to show that the formula $NH_3 = NI_3$ is probably the correct one.

Nitrogen iodide which has been washed with water for a considerable time becomes more liable to explode, and analyses of such partly decomposed material point to a decomposition of the molecule and a liberation of very unstable $NI_3$ in the residue. The latter compound cannot, however, be isolated, and only appears to exist in presence of a large excess of free iodine; it is probably formed by the molecule $NH_3 = NI_3$ breaking down in the first instance into $NH_3$ and $NI_3$, the ammonia being washed away either alone or combined with hydriodic acid,* leaving the $NI_3$ as an insoluble residue mixed with iodine and still undecomposed nitrogen iodide.

The view that the constitution of the so-called "nitrogen iodide" is represented by the formula $NH_3 = NI_3$ is supported to a certain extent by the recent work of Hugot, who found that when iodine was placed in excess of anhydrous liquefied ammonia, it dissolved, and deep green needle-shaped crystals were deposited, whose composition was represented by the formula $3NH_3.NI_3$. Kept at $-30°$ C. in a vacuum, these crystals lost a molecule of ammonia, and left a brass-yellow crystalline body having the composition $2NH_3.NI_3$, ; this latter substance, exposed in its turn at 0° in a vacuum, lost another molecule of ammonia and gave ordinary nitrogen iodide, $NH_3 = NI_3$.

The formula has lately received further confirmation from the observation of Silberrad, that a small quantity of triethylamine is produced when nitrogen iodide suspended in ether is acted upon by zinc ethyl.

During the past few years much work has been done on substituted nitrogen chlorides and bromides, classes of compounds previously little known, and the knowledge gained enables us to formulate the behaviour of nitrogen iodide very clearly.

A halogen atom attached to nitrogen behaves in a characteristic way on hydrolysis wholly different from the way it behaves when attached to carbon. In the latter case the halogen atom is replaced by hydroxyl, being itself removed in combination with hydrogen, in the former it is invariably replaced by hydrogen, itself uniting with the hydroxyl group, thus—

$$:C.Cl + H.O.H = :C.O.H + HCl,$$
$$:N.Cl + H.O.H = :N.H + H.O.Cl.$$

All reactions of nitrogen iodide, therefore, carried out in presence of water may be formulated as if the nitrogen iodide first became hydrolysed into ammonia and hypoiodous acid, $NH_3.NI_3 + 3HOH = 2NH_3 + 3HOI$, the latter then interacting in its own characteristic manner.

The reactions of nitrogen iodide are, however, complicated by the circumstance that a partial breaking down of the compound into nitrogen and hydrogen iodide almost invariably accompanies the main reaction. This secondary reaction, $NI_3.NH_3 = N_2 + 3HI$, takes place to a greater or less extent according to the nature of the main reaction and the conditions under which it is taking place, and is especially promoted by the influence of light. Since hydrogen iodide reacts at once with hypoiodous acid, liberating iodine, the latter element is nearly always set free when the nitrogen iodide enters into any chemical action. This circumstance, coupled with its explosive nature, has caused all the difficulty which has been experienced in its investigation.

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To Purify Drinking-water.—M. Lambert proposes to add 6 c.grms. of permanganate of potash to each litre, and, ten minutes after, 10 c.grms. of manganese sulphate. After precipitation carefully decant.—*Chemist and Druggist.*

* The hydriodic acid is formed by a secondary decomposition, identical with that which takes place under the influence of light, which occurs to a small extent; the nitrogen simultaneously formed escapes as gas. The iodine is set free by the action of this hydriodic acid upon a further portion of the nitrogen iodide.

# THE QUANTITATIVE DETERMINATION OF CARBON DIOXIDE AND OF CARBON.

By JOHN McFARLANE and ARNOLD W. GREGORY.

In the determination of small percentages of carbon or of carbon dioxide, the absorption of the latter in weighed potash bulbs is unsatisfactory on account of the small increment of weight. Thus, as A. A. Blair points out ("Chemical Analysis of Iron," p. 148), "in damp weather it is almost impossible to get good results, the condensation of moisture on the absorption apparatus rendering the weighing extremely difficult, even when the utmost care is taken." Our own experience in the determination of carbon in steels of low carbon content fully bears out Blair's remark.

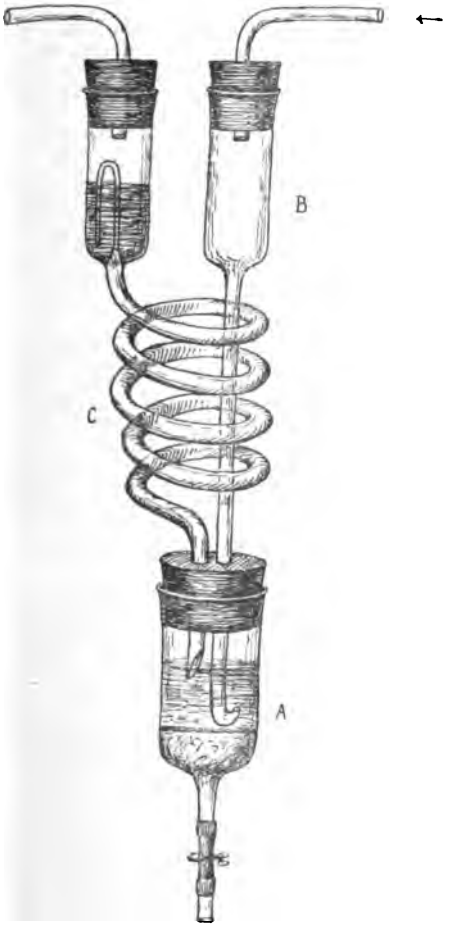


FIG. 1

The following example makes the difficulty apparent:—Three grms. of steel were burned by the direct combustion method, and the carbon dioxide absorbed in a weighed potash bulb. The increase in weight was 0·0110 grm., equivalent to 0·10 per cent carbon. A difference of 1 m.grm. in the above weight would cause an error to the extent of about 10 per cent of the carbon present.

This fact led us to adopt the barium hydrate absorption method, first proposed by Pettenkoffer.

The advantage of this method of absorption lies in the fact that 197·4 parts of barium carbonate are formed from 12 parts of carbon, whereas only 44 parts of carbon dioxide are produced from a similar amount of carbon.

Moreover, as Dupré and Hake have shown (*Journ. Chem. Soc.*, xxxv., 1159) the barium carbonate, which is only removed from the absorption apparatus with difficulty, may be dissolved in hydrochloric acid, and finally converted into barium sulphate, 233·46 parts of which correspond to 12 parts of carbon.

At the same time there will be a loss of alkalinity in the filtrate from the barium carbonate, so that by using a measured quantity of barium hydrate solution of known strength and titrating the filtrate after absorption of $CO_2$ with standard acid solution, the amount of carbon or carbon dioxide may be calculated. This gives two methods for determining carbon or carbon dioxide in a single absorption.

There are two chief difficulties, however, in using barium hydrate solution; first, a large volume of the solution is required on account of the sparing solubility of barium hydrate, and thus a cumbersome absorption apparatus must be used; secondly, during the process of filtration carbon dioxide may be absorbed from the atmosphere, which fact constitutes a serious disadvantage of the method.

In order to overcome the second difficulty, F. A. Gooch and K. Phelps (*Zeit. Anorg. Chem.*, 1895, ix., 356—359) use a layer of xylene on the surface of the barium hydrate solution.

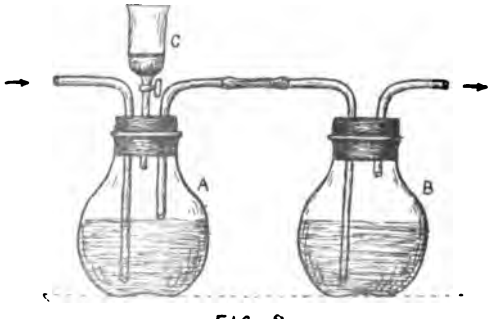


FIG. 2

By using the apparatus about to be described this is unnecessary, since filtration takes place in an atmosphere freed from carbon dioxide. Efficient absorption is produced by the prolonged contact of the gas with a minimum volume of liquid. Filtration and absorption take place in the same apparatus.

Fig. 1 consists of a wide filter-tube, A, closed by a small piece of rubber tubing and a clip. A plug of glass-wool is inserted into the base of the wider part, and covered by a layer of paper or asbestos pulp. It is advisable to cover the pulp with a little broken glass, which serves to keep it in position during the agitation of the liquid caused by the passage of the gas. The mouth of the filter-tube is closed by a rubber stopper with two holes, through one of which passes a glass tube, B, bent and constricted at its lower end, and enlarged at its commencement as shown in Fig. 1.

Through the second hole a spirally bent tube, C, is placed, which terminates in the same form as the inlet tube B commences, except that a small inverted U-tube is fused inside.

Before making a determination, air, freed from carbon dioxide, is passed through the apparatus, which is connected to the combustion tube or evolution flask. When all carbon dioxide is removed, the rubber stopper in the mouth of B is taken out, and a measured quantity of the barium hydrate solution introduced. The liquid now fills the filter-tube, A, and partially fills the spiral, C. The stopper in B is now replaced, and the current of air once more passed in, whereupon some of the liquid from the spiral is carried

over through the small inverted U-tube into the enlarged termination of C.

The determination is now commenced. Carbon dioxide passes through B, then on to A, where absorption chiefly takes place, and finally the last traces of the gas are retained in the spiral. The barium hydrate in the termination of C should remain clear if absorption is complete in the spiral, but unless care is taken barium carbonate will be carried mechanically through the small U-tube.

When all the carbon dioxide is absorbed, the clip on A is opened, and the filtrate collected. The barium hydrate is washed out of the apparatus with boiling water to which a few drops of phenolphthalein solution have been added, the washing being discontinued when the filtrate only shows a very faint pink colour. The filtrate and washings are mixed, and the solution titrated with N/10 $H_2SO_4$, and the carbon or carbon dioxide calculated from the loss of alkalinity of the barium hydrate.

The barium carbonate in the apparatus is dissolved in very dilute hydrochloric acid, and converted into barium sulphate, filtered, ignited, and weighed.

From the weight of barium sulphate the carbon or carbon dioxide may be calculated. We obtained excellent results with this apparatus in the determination of small quantities of carbon dioxide, but in dealing with larger quantities the barium carbonate formed being gelatinous in nature, and large in quantity, rendered filtration difficult, and the precipitate appeared to occlude a trace of barium hydrate, since the results obtained were very slightly but consistently high; this effect, however, being minimised by the large amount of barium sulphate derived from a small amount of carbon.

Thus in an extreme case the weight of barium sulphate was 10 m.grms. in excess of that demanded by theory, giving an excess of 0·5 m.grm. of carbon over the amount present.

In working with very large amounts of carbon dioxide the difficulty of filtration is so great as to render the method impracticable, and also in this case the efficiency of absorption is limited by the sparing solubility of barium hydrate.

Another method which we have used consists in absorbing carbon dioxide in an ammoniacal barium chloride solution, when soluble barium carbamate is formed, which, however, is unstable, so that a slight precipitation occurs even in the cold. On warming, the precipitate of barium carbonate increases, and at the boiling-point a quantitative yield is obtained.

Barium carbonate thus differs from calcium carbonate in being completely precipitated on boiling in presence of ammonia, as E. Divers (*Journ. Chem. Soc.*, xxiii., 230 and 360) states that caustic ammonia in presence of excess of calcium chloride very considerably retards the precipitation of calcium carbonate, and Drechsel (*Journ. Prakt. Chem.*, [2], xvi., 180—200) finds that calcium carbonate is not completely decomposed on prolonged boiling in presence of ammonia. Fresenius describes this method ("Quantitative Chemical Analysis," vol. i., p. 332, English edition), and concludes that it is not capable of giving good results unless numerous precautions are taken.

Thus, Fresenius recommends that, after the absorption of the carbon dioxide, the ammoniacal barium chloride be heated for one and a-half to two hours in a tall vessel of water at 98° C., since active ebullition would occasion loss of ammonium carbonate, due to the action of ammonium chloride on the precipitated barium carbonate. The hot solution is then filtered.

Our experiments show that precipitation of barium carbonate is complete after boiling for one minute, and that the action of the ammonium chloride on the barium carbonate is so slight as to be negligible.

The following experiment proves the correctness of the first statement:—Carbon dioxide was passed into an ammoniacal barium chloride solution, so that the latter still remained in considerable excess. The solution was then boiled for one minute, and filtered into a flask through which air freed from carbon dioxide was passing. The solution was then heated for an hour. No precipitation occurred.

Instead of filtering the hot solution, we first allow it to cool, and then filter, so that any carbon dioxide which is absorbed from the atmosphere during the process forms the soluble carbamate, and passes into the filtrate, whereas on filtering the hot solution, barium carbonate is formed from atmospheric carbon dioxide, and causes the result obtained to be too high. By proceeding in this manner we eliminate the error which arises from the absorption of atmospheric carbon dioxide, the chief difficulty in the use of barium hydrate for the absorption of carbon dioxide.

The solution of barium chloride contains 50 grms. $BaCl_2$ and 250 c.c. ammonia solution (specific gravity 0·880) per litre. In carrying out a determination the ammoniacal barium chloride solution was boiled and filtered into two small flasks, as shown in Fig. 2. C is a filter-tube containing glass-wool covered with asbestos pulp. The exit tube of A is of such a length as to allow the solution to pass over into B when A is half full. Air freed from carbon dioxide is passed through the flasks before the liquid enters.

The greater part of the carbon dioxide is absorbed in the first flask, and the remainder is retained by the second. When the absorption is finished, the flask A is heated (whilst still in connection with the combustion tube) until it commences to boil. The steam generated passes over into B, and both flasks are thus heated to the desired temperature. The flasks are then cooled, and removed from the other part of the apparatus, and the $BaCO_3$ filtered off (a similar filter being used as in the flask A). washed with cold, and finally with hot water.

The barium carbonate on the filter is dissolved in dilute hydrochloric acid, as also any which may have remained on the walls of the absorption flasks and tubes. The solution is boiled and dilute sulphuric acid added, the barium sulphate being precipitated in a granular form, and may be filtered within five minutes of precipitation.

Though the operations involved take a rather longer time than those necessary in the case of absorption by potash, they are simple in nature, and the greater accuracy attainable quite justifies the lengthened process.

We have used this method in the estimation of carbon dioxide in carbonates, and of carbon in steel.

On testing the method, a small quantity of powdered calc spar was weighed in a porcelain boat, and heated to redness in a porcelain combustion tube through which a stream of air freed from carbon dioxide was passed. The tube was allowed to cool, and the boat removed and weighed. The loss of weight gave the weight of carbon dioxide evolved.

*Example* 1.—0·2153 grm. $CO_2$ gave 1·1400 grm. $BaSO_4$.

The weight of carbon dioxide, calculated from the above weight of barium sulphate, is 0·2148 grm.

*Example* 2.—0·3832 grm. $CO_2$ gave 2·0350 grm. $BaSO_4$. Calculated, $CO_2$, 0·3835 grm.

The accuracy of the method for the determination of small quantities of carbon dioxide is shown by the following experiment:—0·0265 grm. of sodium carbonate was dissolved in hydrochloric acid and the carbon dioxide absorbed.

| | | |
|---|---|---|
| Weight of $BaSO_4$ obtained .. | .. | 0·0597 grm. |
| Weight of carbon calculated | .. | 0·00307 „ |
| Theoretical weight of carbon | .. | 0·00300 „ |

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**Copper Steels.**—Pierre Breuil.—The author has already investigated copper steels containing 0·15 to 0·38 per cent of carbon, and he now continues his researches to those containing 0·56 to 0·79 of carbon, and gives a series of tables of his results which show the apparent limit of elasticity, stretching power, &c.—*Comptes Rendus*, cxiii., No. 7.

## NOTICES OF BOOKS.

*Lecture Notes on Chemistry for Dental Students.* By H. Carlton Smith, Ph.G. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1906.

The author of this book has a high ideal regarding the knowledge of chemistry which a dentist should possess, and though probably but few students will come up to this ideal, the use of his book can be recommended for all. It follows the lecture course in dental chemistry as given by Dr. Smith at the Harvard Dental School, and gives full directions for the appropriate practical work. The student is supposed to have had some elementary training in chemistry, both theoretical and practical, and begins his dental course with qualitative analysis. This first part of the book has many good features; for instance, the recognition of the importance of always using solutions of known strength. Then dental metallurgy is taken up, including the chemistry of alloys, amalgams, solders, and cements, directions being given for their preparation. Volumetric and micro-chemical analysis are both very shortly treated, the latter subject being illustrated by a few plates showing the crystals most frequently met with or best suited for the study of micro-chemical processes. The examination of teeth and tartar is then discussed sufficiently fully, while organic and physiological chemistry are given their full share of space, and the student who works through and assimilates the last two sections of the book should be particularly well equipped to understand the problems of dentistry.

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*August Wilhelm von Hofmann.* By Bernhard Lepsius. Leipzig: Duncker and Humblot. 1905.

The life of August Wilhelm von Hofmann has a special interest for English men of science, on account of the important part he played in spreading a knowledge of chemistry in this country while he was Professor at the College of Chemistry, which has sent out numbers of eminent men, many of whom happily are still living. This biography narrates the chief events in the great chemist's life, and gives an excellent account of his many-sided activity, describing shortly the researches which have made his name so universally known. Special stress is laid on those which have important practical applications; for example we need only mention the work on the aniline dyes (in which Perkin was his assistant) and on formaldehyde, which so long eluded preparation in the pure state, and which is of such great biological and hygienic importance. Allusion is also made to Hofmann's literary work and his share in the formation of the Deutsche Chemische Gesellschaft, while a clear picture is given of his charming personality, which won for him so many friends, both in England and on the Continent, and a tribute is paid to his enthusiasm as a teacher and to the generosity with which he placed all the help and encouragement in his power at the disposal of those who came in contact with him.

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*Handbuch der Anorganischen Chemie.* ("Manual of Inorganic Chemistry"). Edited by Dr. R. Abegg. Vol. III., Part I. Leipzig: S. Hirzel. 1906.

The first part of Volume III. of this valuable text-book contains the elements of Group III., namely, boron, gallium, indium, and thallium, and the rare earths. It still preserves its high reputation for comprehensiveness and special attention to physical chemistry, and when it is said that Prof. Brauner is responsible for a large part of the volume, including the chapters on the atomic weights, it will not be necessary to comment further upon the thoroughness and general excellence of the book. The critical discussions of the literature of the elements of the rare earths constitute a special feature, and the particularly complete treatment of these elements would alone be sufficient to recommend the text-book very highly as a work of reference.

## CHEMICAL NOTICES FROM FOREIGN SOURCES.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxliii., No. 6, August 6, 1906.

**Iodomercurates of Sodium and Barium.**—A. Duboin.—The author prepares sodium iodomercurate, $2NaIHgI_2.4H_2O$, a salt which is extremely deliquescent. He also prepares a new iodomercurate of barium by leaving a solution of mercuric iodide in barium iodide (having composition—Barium, 12·45; mercury, 22·53; iodine, 51·68; and water, 13·34 per cent) to evaporate very slowly in dry air through the heat of summer. Enormous crystals are deposited, of density 4 and formula $BaI_2.HgI_2.5H_2O$. The other properties of this salt are very much the same as those of the barium salts which the author has described in a previous paper.

**Alkaline Earth Boro-stannates. Reproduction of Nordenskiöldine.**—L. Ouvrard.—The author's researches on the metallic borates led him to investigate the different methods of obtaining the alkaline earth boro-stannates, of which there exists one natural example, Nordenskiöldine (calcium boro-stannate). He obtains the best results by mixing precipitated borate of lime, of formula $CaO.2B_2O_3$, with a quantity of tin dioxide in a platinum boat; the latter substance being prepared by the calcination of metastannic acid. The boat is then heated to redness in a porcelain tube through which a current of hydrochloric acid slowly passes. After treating the mass thus obtained with acidulated water, &c., the boro-stannate, $B_2O_3.SnO_2CaO$, is isolated. This substance is in the form of colourless, transparent, almost infusible crystals, which are unattacked by concentrated hydrochloric acid.

**Influence of the Temperature of Dehydration of Gypsum on the Hardening Power of the Plaster obtained.**—E. Leduc and Maurice Pellet.—Hitherto no experiments have been made on the influence of the temperature of dehydration of gypsum on the setting power of the plaster obtained. The authors dehydrate gypsum at various temperatures, and then determine the curve obtained by testing the plasters thus prepared by means of a Périn tester. One of the most interesting results obtained is that, when alabaster is dehydrated at 450° no sensible rise of temperature takes place during the setting of the plaster, but if the dehydration takes place at 250° there is a decided rise of temperature (15·5° in twelve minutes approximately.

## MISCELLANEOUS.

**Schools of Chemistry.**—The following additional information has been received:—

Northern Polytechnic Institute, Holloway, N.—Principal, R. S. Clay, D.Sc.; Head of the Chemical Department, W. H. Mills, M.A., Sc.D.; Assistants, W. H. Watson, B.Sc., A.R.C.S., Miss A. M. Bain, M.A., B.Sc., and F. W. Linch. Instruction in Theoretical and Practical Inorganic and Organic Chemistry, Systematic courses for London University Degrees, Pass and Honours, and Board of Education examinations. Session begins September 17. Prospectus free on application to the Secretary.

Northampton Institute, St. John Street, E.C.—Principal, R. Mullineux Walmsley, D.Sc., F.R.S.E., &c. Chemistry: Messrs. S. Field, A.R.C.S., E. B. Ware, A. H. Mundey, F.C.S., G. Naylor, F. Edwards. Evening Courses in Elementary, Applied, and Engineering Chemistry, and Electro-chemistry, Electro-plating, Electro-metallurgy, &c. Day and Evening Courses in Engineering (Mechanical and Electrical), Technical Optics, Artistic Crafts, and Horology. The classes of the Day Courses commence on Monday, October 1st, and those of the Evening Courses on Monday, September 24th. Full details of the syllabuses in the various subjects and the equipment and special developments for the forthcoming session may be obtained on application to the Principal.

**Appointments.**—Dr. Morris W. Travers, F.R.S., Professor of Chemistry at University College, Bristol, has been appointed Director of the Indian Institute of Science which is to be established at Bangalore. The Council of University College, Bristol, have offered the vacant Chair of Chemistry to Dr. Francis Francis, D.Sc., Ph.D., F.I.C. Dr. Francis studied at University College, Liverpool (now the University), and at Erlangen, and has been Assistant Professor at University College, Bristol, since 1903. He obtained the degree of D.Sc. for researches in organic chemistry, and has published many papers in journals of chemical societies both in England and Germany.


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Canvassing will disqualify.

J. A. JOHNSON,
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Southwark Town Hall,
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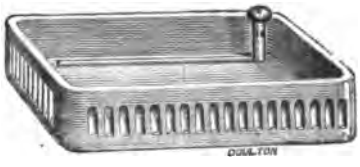

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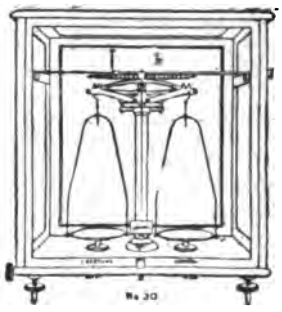

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## OXIDATION IN SOILS AND ITS RELATION TO PRODUCTIVENESS.*

By FRANCIS V. DARBISHIRE, B.A., Ph.D., and EDWARD J. RUSSELL, D.Sc.

All soils possess the power of absorbing oxygen, some to a marked extent. The authors have devised an apparatus for measuring the rate of absorption, and they have studied the influence of various factors and also the connection with the productiveness of the soil.

It has been found that oxidation is mainly, but not entirely, due to the activity of micro-organisms; oxidation still goes on in soil sterilised at 120° C. or by treatment with 1 per cent mercuric chloride, but the rate is only about one-fifth of what it was.

The rate of oxidation does not entirely depend on the amount of organic matter present in the soil. Moisture is essential; as its amount increases, the rate of oxidation also increases, until near the point at which the soil becomes waterlogged. The addition of calcium carbonate or of food, *e.g.*, sugar, increases the rate. In the latter case the maximum increase occurs with 1 per cent of sugar. Small quantities of poison like mercuric chloride, thymol, copper sulphate, &c., also increase the rate till the optimum amount, 0·01 per cent, is reached; further quantities bring the rate down considerably.

Somewhat different results were obtained with partially sterilised soils. If a soil is exposed to vapours of chloroform, carbon disulphide, or toluene, and the antiseptic then removed in a current of air, the rate of oxidation markedly increases. A similar result follows when the soil has been exposed to a temperature of 85° C., insufficient to kill spores.

The rate of oxidation is closely parallel to the productiveness of the soil. For a series of similar soils, of which the cropping power is known, it is found that the most productive has the highest rate of oxidation, and that the others follow in the same order for both properties. The parallelism holds, not only for soils in the natural state, but also, with certain limitations, for soils which have been artificially treated. Thus, partial sterilisation by heating to 95° increases the rate of oxidation and also increases the productiveness for non-leguminous plants; treatment with volatile antiseptics has the same result. It is essential, however, that the soil conditions should be aërobic, as in arable soils; pasture soils, where the conditions are anaërobic, do not show the same relationship. In view of this difference the authors suggest that the rate of oxidation affords a measure of the bacterial activity, which is closely connected with productiveness.

## RESEARCHES ON HIGH PERCENTAGE OZONE GAS.†

By ERICH LADENBURG, Ph.D.

The research which I have the honour to bring before you has been made in the Physical Laboratory of Professor Rubens, together with Dr. Erich Lehmann, assistant of Professor Miethe.

Four years ago E. Goldstein described a method of making pure liquid ozone. He put pure oxygen into a vacuum tube under a pressure of 3 to 5 c.m., and allowed the discharge of a small induction coil to pass through the gas. Under the influence of the ultra-violet light of this discharge the oxygen is changed into ozone, and by cooling the tube with liquid air this ozone becomes liquefied; the pressure in the tube falls to one-twentieth of a millimetre; that is, to the pressure of liquid ozone of that low temperature. Continuing this process one gets 2 c.c. of liquid ozone in one hour.

By allowing this liquid ozone to vaporise into a vacuum tube, it ought to be possible to get pure, or nearly pure, ozone gas. We have made this experiment, and could confirm the above-mentioned supposition. We obtained a gas which had a dark-blue colour in 30 c.m. thickness under a pressure of 200 m.m. In examining the absorption spectrum of this gas we hoped to get more accurate results than previous observers, who could only use an 8 percentage ozone for their researches. Among these scientists, Chappuis examined the visible, Hartley the ultra-violet, and Angstrom the infra-red part of the absorption spectrum of ozone.

We used the following methods of observation:—In the ultra-violet part we photographed the absorption spectrum with a quartz spectrograph, and measured the absorption bands on the photograms. In the visible part we also photographed, or we used an ordinary spectrometer. In the infra-red we made use of a mirror spectrometer with thermopile and galvanometer. In the ultra-violet we used quartz as the prism and for closing our ozone tubes, and in the infra-red rock-salt.

Burning magnesium ribbon was employed as the source of light for the ultra-violet, incandescent gas for the visible, and a Nernst lamp for the infra-red part. For measuring the pressure in the ozone tube, we could not use an ordinary gauge, because ozone immediately attacks all metals. Therefore we tried to blow a glass gauge similar to the metallic gauge which was used by Bourdon. We obtained an instrument with which we could accurately measure the half of a millimetre of pressure.

The following are the results of our researches on the absorption spectrum of ozone:—

In the ultra-violet ozone has a very peculiar kind of absorption. If the proportion of ozone is very small, we find in harmony with the results of previous observers an absorption commencing in the ultra-violet and reaching to 0·31 $\mu$. With a larger proportion of ozone a great number of new bands appear at the ultra-violet end of that part of the spectrum, which previously did not exhibit any absorption bands. The more the amount of ozone increases the more these bands appear in the region of longer waves and become enlarged until the whole of this part of the spectrum is absorbed.

In the visible part of the spectrum we found fourteen absorption bands, and besides these bands we got a great weakening of the red end of the spectrum extending to 0·50 $\mu$. And we believe this weakening is the cause of the blue colour of ozone gas.

In the infra-red we found a great number of absorption bands, the largest of which lies between 9 and 10 $\mu$, and here ozone absorbs nearly 100 per cent.

In liquid ozone, which we also examined, we did not find any absorption bands, but only a great weakening of the red end of the spectrum. This is the cause of its blue colour.

Besides the above-mentioned absorption bands we found five new ones in the visible red part at the following points of the spectrum, namely,—

670—667, 638, 628, 622, and 610 $\mu\mu$.

The existence of these bands confirmed a supposition which I had drawn a year ago in order to explain peculiar results obtained when examining the ratio of the two specific heats of ozone. I obtained numbers which were too small for a triatomic gas. I was consequently compelled to assume there must be another body present in the ozone.

These five bands showed quite different properties from

* Abstract of a Paper read before the British Association (Section B), York Meeting, 1906.

† A Paper read before the British Association (Section A), York Meeting, 1906.

the ozone bands. They only appeared after the greater part of the ozone was vaporised, and they disappeared very soon. First we thought that these bands also belonged to the ozone and did not become visible until a certain degree of pressure had been reached. But this was proved not to be the case, as we obtained these bands even when we had only a very small quantity of ozone, and, on the other hand, we always observed an increase of pressure in connection with their disappearance. Therefore they must belong to another body, and we tried to separate this unknown body from the ozone. For that purpose we used a second absorption tube which we could shut off from the first by a tap. At the moment in which we saw the new bands appearing in the first tube we closed this tube and allowed the rest of the liquid to vaporise into the other tube. And here we found the new bands without the ozone bands. Therefore it was proved that they belonged to a new body. We had made the liquid ozone by an oxygen which was developed by electrolysis of boiled potassium hydrate, and the whole apparatus was exhausted as far as possible before beginning with the experiments. Therefore we excluded the presence of nitrogen as well as that of other impurities. And consequently we have to believe that this body, which the five new bands belong to, is a third modification of oxygen, and this being the case it must have more atoms in its molecule than ozone, because the pressure increases with the disappearance of this body. The amount of the increase of pressure was so great that it seemed to be possible to prove our opinion by an examination of the specific gravity of the gas which vaporised from the liquid ozone. We measured volume, weight, pressure, and temperature of the gas, and obtained the following six results for its specific gravity :—

1·738, 1·832, 1·751, 1·768, 1·737, 1·840,

the average being 1·774.

The specific gravity of the triatomic ozone would be—

1·661.

It is not very easy to work with pure ozone, and especially with this new body, because they are very explosive, and we could not yet determine the conditions of these explosions.

Therefore we have only examined very few properties of the new body. But the following is certain :—

It has a higher boiling-point than ozone, it has more atoms in its molecule, it is of a dark blue colour, whether liquid or gaseous, and it is not very stable at the ordinary temperature.

## A METHOD FOR DETERMINING VELOCITIES OF SAPONIFICATION.*

By Professor JAMES WALKER, F.R.S.

A possible method of following the progress of a reaction in which electrolytes are involved is to measure the electrical conductivity of the solution at stated intervals. This method was employed by Walker and Kay in their investigation of the conversion of ammonium cyanate into urea, and is capable of a more extended application (*Journ. Chem. Soc.*, 1897, lxxi., p. 489).

The chief conditions for the convenient application of the method are :—First, that there should be a considerable difference in conductivity between the initial and final systems; and, second, that the change in conductivity should be proportional to the progress of the reaction. It occurred to me that these conditions would be well fulfilled in the saponification of an ester by a caustic alkali. The conductivity of the alkali—say sodium hydroxide—is much greater than that of the sodium salt produced by the saponification, owing to the high velocity of hydroxidion as compared with the salt anion. Since, too, sodium hydroxide and sodium salts of monobasic acids are approximately equally ionised under the same conditions, the ionisation in dilute solution remains practically the same throughout the saponification, and thus the alteration in the conductivity is almost exactly proportional to the progress of the reaction.

The following experiment on the rate of saponification of methyl acetate by caustic soda may be quoted as an example of the method carried out under ordinary laboratory conditions with the apparatus generally used for conductivity measurements in solution.

The conductivity cell used was of the narrow Arrhenius type, and was immersed in a thermostat at 25°. In this cell were placed 4 c.c. of N/20 caustic soda and 15 c.c. of water. To prevent access of carbon dioxide, the hole in the ebonite cover was plugged with a small rubber stopper. When the temperature of the thermostat had been reached, the solution was stirred by raising and lowering the electrodes, and the conductivity was read off. To the solution was then added 1 c.c. of N/5 solution of methyl acetate, the time being simultaneously noted, and the contents of the cell were well stirred by up and down motion of the electrodes. A reading of the conductivity was at once taken after mixing, but this acted merely as a check, and was not used in the calculation. After a short interval readings were made of the conductivity of the solution (which was now N/100, both with regard to sodium hydroxide and to methyl acetate), at first every minute, and then every few minutes when the reaction had become slower.

The following table contains the results of the observations. In it $a$ represents the bridge reading and $x$ the difference between the initial value of $a/(1-a)$, which is proportional to the conductivity, and the value after $t$ minutes.

| $t$. | $a/(1-a)$. | $x$. | $\frac{1}{t}\cdot\frac{x}{1-x}$ |
|---|---|---|---|
| 0 | (1·564) | 0 | — |
| 3 | 1·304 | 0·260 | 0·117 |
| 4 | 1·247 | 0·317 | 0·116 |
| 5 | 1·198 | a·366 | 0·115 |
| 6 | 1·153 | 0·411 | 0·116 |
| 7 | 1·114 | 0·450 | 0·117 |
| 8 | 1·083 | 0·481 | 0·116 |
| 10 | 1·026 | 0·536 | 0·115 |
| 12 | 0·980 | 0·584 | 0·117 |
| 15 | 0·927 | 0·637 | 0·117 |
| 18 | 0·883 | 0·681 | 0·118 |
| 21 | 0·852 | 0·712 | 0·118 |
| 25 | 0·818 | 0·746 | 0·118 |
| ∞ | (0·564) | (1·000) | Mean 0·118 |

It will be noticed that the constant for the bimolecular reaction is here very satisfactory, and in general it may be said that the maximum divergence from the mean value does not exceed 1 to 2 per cent. It is, however, advisable to neglect the first and last fourths of the reaction, since in them initial disturbances and the effect of a slight departure from exact equivalence of the reacting substances have a relatively large effect on the value of the constant.

The initial reading of the conductivity cannot be taken directly, owing to the great speed of the reaction. In order to obtain it, the conductivity of the alkaline solution is read before the methyl acetate is added. In the above instance the conductivity read in this way is that of a solution N/95 with regard to sodium hydroxide, 4 c.c. of N/20 solution being contained in 19 c.c. When this is diluted to N/100 by the addition of 1 c.c. of the methyl acetate solution, the conductivity will fall off in the ratio of 100 to 95, since the quantity of methyl acetate in the solution after mixing is less than 0·1 per cent, and can have no appreciable effect either on the speed or the number of the ions. From the conductivity of the solution before addition of the methyl acetate we therefore deduct one-twentieth of its value in order to obtain the initial conductivity after mixing.

* A Paper received by the Royal Society, July 10, 1906. From the Chemical Laboratory, University College, Dundee.

The final reading may, of course, be ascertained by waiting till the action has ceased, but it is both more expeditious and more accurate to measure the conductivity of a N/100 solution of sodium acetate prepared by neutralising the N/20 solution of caustic soda by means of acetic acid and diluting to the requisite extent. It is well to make this measurement of the end-point before beginning the actual saponification. Theoretically the end-point can be calculated from the initial reading and the known ratio of the conductivities of N/100 solutions of sodium hydroxide and sodium acetate, but it is advisable to perform the experiment as a check.

The calculation of the constant $\frac{1}{t} \cdot \frac{x}{1-x}$ may be simplified by the following device:—For conductivity work a table is used which gives the ratio $a/(1-a)$ for different values of the bridge-reading $a$. If, therefore, we make the total range of the reaction equal to unity, we can use the same table to obtain the ratio $x/(1-x)$ and have then merely to divide by the time, $t$,—a calculation which can be performed mentally if the intervals are suitably chosen. Now it is always possible to make the range between the initial and final values of $a/(1-a)$ equal to unity by introducing the appropriate resistance in the resistance box. Thus, in the above example, it was found that the ratio between the initial and final conductivities was 2·773 : 1. We have, then, $i/f = 2{\cdot}773$, and we wish to make $i - f = 1$. From these two equations we obtain $i = 1{\cdot}564$ and $f = 0{\cdot}564$. We have therefore so to adjust the resistance that the initial value of $a/(1-a)$ shall be 1·564. This refers to the N/100 solution after mixing, whilst the conductivity actually measured is that of a N/95 solution. We must therefore increase the value 1·564 in the ratio of 100 to 95, and thus obtain 1·646 as the value of $a/(1-a)$ which the N/95 solution of caustic soda must exhibit if the difference between the initial and final values of $a/(1-a)$ is to be unity. In the table this value of $a/(1-a)$ corresponds to $a = 0{\cdot}622$. We therefore adjust the resistance in the box, either by trial or by calculation, until the minimum for the N/95 solution of caustic soda is exactly at this part of the bridge, and then proceed with the experiment. This adjustment, though tedious in description, only occupies a few minutes in practice, and saves much time in the subsequent calculations. Even if readings are taken every minute, the calculation of the constant $\frac{1}{t} \cdot \frac{x}{1-x}$ from each observation can be performed in the interval between two readings, generally without the necessity of putting pen to paper.

To obtain the velocity constant from the mean value of $\frac{1}{t} \cdot \frac{x}{1-x}$ it is only necessary to divide by the normality of the solution. In the above instance the velocity constant is thus $0{\cdot}117 \div 0{\cdot}01 = 11{\cdot}7$.

As a further example of the method, I append a series of observations made by Mr. D. C. Crichton, B.Sc., on the velocity of saponification of ethyl acetate by caustic soda at 24·85°, the concentration of both substances being N/100.

| $t$. | $a/(1-a)$. | $x$. | $\frac{1}{t} \cdot \frac{x}{1-x}$. |
|---|---|---|---|
| 0 | (1·560) | 0 | — |
| 5 | 1·315 | 0·245 | 0·0649 |
| 7 | 1·247 | 0·313 | 0·0651 |
| 9 | 1·193 | 0·367 | 0·0645 |
| 11 | 1·146 | 0·414 | 0·0642 |
| 13 | 1·101 | 0·459 | 0·0652 |
| 15 | 1·064 | 0·496 | 0·0650 |
| 18 | 1·020 | 0·540 | 0·0652 |
| 20 | 0·994 | 0·566 | 0·0652 |
| 25 | 0·945 | 0·615 | 0·0642 |
| 27 | 0·923 | 0·637 | 0·0650 |
| 33 | 0·880 | 0·680 | 0·0644 |
| 37 | 0·756 | 0·704 | 0·0644 |
| ∞ | (0·560) | (1·000) | Mean 0·0647 |

The velocity constant of the saponification of ethyl acetate by caustic soda at this temperature is therefore 6·47, a value in exact accordance with the curve which expresses the results of Warder (*Am. Chem. Journ.*, 1881, vol. iii., p. 203) and of Reicher (*Liebig's Annalen*, 1886, vol. ccxxxii., p. 103) obtained by the titration method.

The conductivity method, even without special apparatus, is at least as accurate as the titration method carried out under specially favourable circumstances, and for rapid reactions is incomparably less trying in execution.

## ORE DEPOSITS AND THEIR DISTRIBUTION IN DEPTH.*

By Prof. JOHN W. GREGORY, D.Sc., F.R.S.

Primitive man obtained his limited store of metal by gathering scanty grains and pebbles of ore from the beds of streams; but even in pre-historic times he worked shallow mines, for Job tells us that the gold miners of his day not only diverted rivers from their courses, as in modern alluvial practice, but they put forth their hands upon the flinty rock, by which he doubtless meant quartz. Still less do alluvial ores satisfy modern requirements, even though the great metal-using countries place the rest of the world under tribute of its mineral wealth; and owing to the exhaustion of the richer ores in the more accessible mining fields, miners are now thawing the frozen gravels of Klondike, washing the gold-bearing loams in the Siberian rivers during their short summer flow, mining in the malarial jungles of West African coast lands, and sluicing low grade drifts in the heart of Africa, in Katanga.

We cannot expect many more discoveries of alluvial deposits as rich and as extensive as those of California and Australia; nor can we go back to the low metal output of a century ago. The exhaustion of coal we destroy so wastefully might not be an irremediable disaster, for there are other sources of heat and power; but the metal famine that would follow a return to the metal supplies of 1800, or even 1850, would destroy the whole fabric of our civilisation.

The supply of metals can be maintained in two ways. We may work superficial alluvial deposits with more refined methods of metal recovery; or we may mine the more deeply buried primary ore-deposits.

The simple method of collecting ores is to wash the gravels that contain them in a tin dish; but this method is only profitable with ground so rich that it can be handled in small quantities. Poorer material can be washed in simple machines, but they are only successfully economically when the ore has undergone preliminary concentration by nature. Sluicing and dredging recover profitably the minute grains of ore scattered through thick sheets of barren material. Dredges work with marvellous economy. A dredge will haul up a ton of gravel from a river bed, sort it, wash it, and extract its gold, at the cost of three halfpence. It has been predicted that this invention, which we owe to New Zealand, will so greatly increase the gold yield of the world, as to repeat the revolutionary effect on prices occasioned by the gold discoveries of California and Australia in the middle of the last century.

But economical though these dredges be, it is doubtful whether they can maintain an adequate metal supply, and we are becoming increasingly dependent on the mining of deeper ore-deposits. They belong to two main groups:—

1. Ores of alluvial and sedimentary origin.
2. Ores deposited in lodes and masses.

Deep alluvial and sedimentary ores only pay to work for precious metals, and practically only for gold. They are of two main types: deep leads and buried sheets of gold-bearing conglomerates. The deep leads are the beds of

* A Discourse delivered at the Royal Institution, April 27, 1906.

old rivers, which have been buried under thick sheets of river deposits or lava flows. In working these deposits the course of the old rivers has to be discovered by boring through the overlying rocks; and when the old river system has been mapped out, the miner can pump the gravels dry, then dig them out, and extract from them their gold.

The only deeply buried, wide sheet of gold-bearing sedimentary rock which is of first-rate mining importance is the banket of the Transvaal. The banket is a marine conglomerate, composed of pebbles of quartz, and some pebbles of what is now pyrites. The rock was doubtless formed on a sinking shore-line. According to the explanation which seems to me most probable, the Rand gold was derived from the wearing away of gold bearing quartz lodes. The sheets of pebble-reef have been traced east and west through the length of the Rand; and they may occur to the south of Johannesburg, in the bottom of a great basin, far deeper than they can at present be profitably worked. Preparations are being made for mining the banket at the depth of 5000 and even 6000 feet, and if the gold be alluvial in origin, the limit of working will be determined by expense, and not by any limit in its distribution. It is, however, authoritatively held that the Rand gold is not alluvial in origin, but has been formed by impregnation, as in ordinary gold-quartz lodes. If so, the banket is only a very abnormal lode, and the downward limit of its ores will depend, not on the depth to which the conglomerate goes, but on the factors that control the deposition of ores in lodes.

*Lode-caps.*

The future metal supply of the world will doubtless come from ores deposited by secondary processes in lodes or masses, and the depth to which these ores extend depends on the depth at which these secondary processes can take place.

The lodes are generally first found and worked on the surface. The lodes may occur as walls of rock, left upstanding by the wearing away of the soft slates beside them. Lode mining began in Australia by a party of miners chipping out the pieces of quartz that contained visible gold from such an outcrop, and then breaking up the quartz with hammers.

The exposed part of the lode having been used up, the miners follow it downward as deeply as it pays them to go with the appliances available to them. Mining has shown that there are two main types of lodes; some ores are in flat sheets or veins, others in huge masses, which may consist of solid blocks of ore, or of rock impregnated by veins, veinlets, or even scattered grains. Both types of ore-deposits, when followed down, are often found to become thinner and perhaps to pinch out altogether. Even if the lode continue downward, there is soon a marked change in the character of the ores. Thus, in a gold-quartz lode, the work is easy near the surface, till the miner reaches the level where the rocks are charged with water; this change occurs at a depth which varies indefinitely, and may be as much as 1600 feet, but is often met at from 80 to 150 feet. Then comes a great increase in the difficulty of mining, and a great decrease in its profit.

Above water level the rocks are soft and decomposed, and full of cavities; below they are hard and compact; above that level they are dry, below they are wet, so water oozes into the excavations which have to be kept empty by costly pumping. The ore above water level is stained rust-red, and the gold is visible, so the good and barren ground are readily distinguished; below that level the ore is dark in colour, and usually charged with pyrites, with which the gold is combined, so it is no longer to be seen by the eye. The gold, moreover, may be associated with minerals, which may hamper its extraction. Hence, instead of the miner having to deal with an ore from which the gold can be easily obtained, it becomes refractory, and may require difficult metallurgical treatment. Again, the upper part of the lode being full of cavities, from which heavy materials have been removed, a cubic foot of it weighs less than a cubic foot of the compact lode below, so the gold, if equally distributed, is richer per ton weight of ore above than below water level.

Hence a party of miners finds that a lode, which has paid them handsomely at first, in time becomes quite unprofitable; and the only thing to be done, when the incoming of the sulphides announces the end of the easily mined ore, is to sell the mine to a company, and start farming with the money.

*The Lateral Secretion Theory.*

The conversion of successful working miners into farmers was once stimulated by the widespread belief that these changes in the lodes indicated that gold is a surface formation, and that gold quartz lodes would not persist below the depth of about 300 feet. Thus, according to Sir Roderick Murchison, "as frequently as deep mines enriched the speculators who sought for copper and silver, so surely gold mining in the solid rock proved abortive, owing to the slender, downward dissemination of gold in a hard and intractable matrix." And he maintains that it is an "indisputable fact that the chief quantities of gold, including all the considerable lumps and pepitas, have been originally imbedded in the upper parts of the vein-stones." Murchison insisted repeatedly on the essentially superficial distribution of gold ores.

It is true that many of the earliest students of ore-deposits regarded all ores as derived from a "Pluto's Hoard" in the inner recesses of the earth. But this view was opposed to many of the most obvious facts. Thus lodes are often found to be closed below, in which case it is easier to explain them as filled from above, or from the sides, than from below. Again, lodes are often poor below and rich above, whereas the contrary would be expected if the heavy ores came from the interior of the earth. The veins known as gash-veins, which are entirely confined to one bed of rock, can therefore only have received their contents from it; yet the contents of these gash-veins are identical with those of the great fissure lodes, and so they also may have obtained their materials from the rocks beside them.

A further strong argument in favour of the local origin of the lodes is the character of the vein-stuffs, the non-metallic lode materials in which the metallic minerals occur. These vein-stuffs vary according to the rock beside the lode. Where a lode traverses sand-stone or other siliceous rocks, the vein-stuffs consist mainly of quartz; when it traverses limestone or igneous rock rich in lime, calcite is a common vein-stuff. In such cases it is obvious that the vein stuffs have been brought from the sides and not from below; and the ores are so intimately mixed with the vein-stuffs that it was natural to infer that both had been introduced by the same agency, and had been derived from a common source.

The lodes, moreover, in many mining fields show essential dependence on the rocks beside them, and apparent complete independence of the rocks below. Thus, in Cumberland, the lead lodes are apt to be broad and rich where they occur in limestone, and narrow and barren where they traverse shale and sandstone. Again, in the famous copper-field of Thuringia, the ores are confined to those parts of the veins that occur in a narrow band of slate, above and below which they are practically always barren. It was claimed that the ores had been originally precipitated from the water of the sea during the deposition of the copper-slates, and subsequently concentrated in the veins.

The first adequate scientific statement of the theory that the ores in lodes are leached out of the rocks in which the lodes occur, was by Bischof in 1847. His pupils endeavoured to justify this lateral secretion theory by demonstrating the existence of metals in ordinary rocks; but for thirty years their efforts were practically in vain. Then Fridolin Sandberger varied the method of search.

Most sedimentary rocks contain small quantities of

accessory minerals, consisting of fragments of the more durable constituents of igneous rocks. The bright idea occurred to Sandberger that if any metals occur in sedimentary rocks, they would be found in these accessory minerals. An element present as a mere accessory constituent, in a scarce accessory mineral, would form an infinitesimal proportion of the rock, and it would thus escape detection on a bulk analysis. So Sandberger first concentrated the accessory constituents, and then analysed these concentrates. The result was the discovery that minute quantities of various metals, including lead, zinc, copper, cobalt, nickel, &c., are widely distributed in rocks, and especially in the old slates, in which most ores occur.

This discovery removed the one objection to the lateral secretion theory that had appeared insuperable, for it showed that the common rocks, in which lodes occur, contain a supply of metal which lateral secretion can collect into lodes.

It is always a pleasure to solve a difficult problem by substituting known forces, working on accessible materials, for unknown agents, acting under conditions and on materials that must ever remain beyond the range of experiment and direct observation. So the lateral secretion theory at once sprang into popularity; and it was applied in one after another of the great mining fields of the world. Thus Emmons attributed the origin of the silver-lead ores of Leadville to lateral secretion from the overlying porphyrites. Becker derived the silver of the Comstock bonanzas from the adjacent diorites and andesites; Chamberlin and Kendal taught us to look for the source of the lead in the gash-veins of Wisconsin and of the North of England, to the limestone in which the veins occur; Howitt and Rickard advocated the view that the gold in the quartz lodes of Australia has been leached out of slates, into which it had been precipitated from the water of the Silurian seas.

But this fascinating and simple lateral secretion hypothesis is now generally abandoned. To mention only one strong objection, it does not explain the occurrence of lodes with different ores in the same country rock. Moreover, it supplies no explanation of the original source of the metals and the ores. For the metals found in the accessory minerals of sedimentary rocks are not necessarily present in them as primary constituents; they appear to have been subsequently introduced, for they are associated with minerals which the microscope proves to be secondary in origin.

The study of ores in recent years has made great progress by recognition of the fact that an ore is a rock, and must be studied on the same lines as ordinary rocks. The microscopic study of ores is throwing much the same light on their depth and distribution as it has done on the depth and genesis of igneous rocks. A rock is investigated both in the field and under the microscope in reference to three main problems:—first, the origin of the materials of which the rock is composed; second, the nature of the agents which have carried the materials to their present position; and third, what deposited them there.

The materials of any rock or ore can only come from one of three sources:—

1. Matter dissolved in the waters of the sea.
2. The igneous rocks which, either directly, or indirectly as the sedimentary rocks derived from their destruction, form the whole of the earth's crust.
3. The interior of the earth.

### *Sea-water as a Source of Gold.*

Gold is the only metal for which the sea is considered a possible original source. The existence of gold in sea-water was first seriously advocated about fifty years ago to explain the occurrence of gold in some plates of Muntz metal that had been used as the sheathing of a ship, which had been trading for three years in the Pacific. It is true that plates of Muntz metal fresh from the works also contained a trace of gold. But the amount in the plates that had been exposed to the sea was larger than in new plates, and the excess was explained as due to gold electrolytically deposited from sea-water. This view appeared the more plausible when, in 1872, Sonstadt announced that he had detected the presence of gold in minute quantities in the water of the Irish Sea. Professor Liversidge, of Sydney, who has followed up this question with greater preseverance than any other chemist of equal distinction, has detected from ¼ to 1½ grains of gold to the ton of sea-water from samples collected on the coasts of Australia, and in the middle of the Indian and Pacific Oceans.

A grain of gold dissolved in a ton of sea-water is not a very large amount. One grain per ton is about 0·0000006 per cent. And condensed sea-salts, even if none of the gold were lost in evaporation, would have but 1 grain of gold in 78 lbs. of sea-salt, or one part in 546,000. To detect these amounts requires chemicals of wonderful purity and chemists of the highest skill. It is not, therefore, surprising that some chemists have failed to find gold in the sea, or have found it in far smaller quantities than Professor Liversidge has obtained.

But if gold be present in sea-water to the amount of only a grain to the ton, the gross amount is temptingly large, for it has been calculated that at that rate, there is enough gold in the sea to supply every human being with the useless dowry of 75 tons of gold.

Geologists accept the presence of gold in the sea on the authority of the chemists. But that the sea is the source of the gold in our lodes is a very different matter. The amount of gold in the sea is so small that it does not appear to follow the ordinary processes of precipitation. Gold is a metal that is very readily precipitated from solution. It is most likely present in the sea as some chloride, and gold is thrown out of chloride solutions by the action of light in the presence of organic matter. But some careful analyses of mud from the sea-floor, at positions where gold should be steadily precipitated by these agencies, have shown no trace of it.

Moreover, the essays of Dr. Don, confirmed by those of Mr. W. H. Bailey in the laboratory of the Mines Department of Victoria, have shown that the slates, from which the quartz lodes were supposed to have got their gold, contain none, except when they also contain pyrites; and the microscope proves that the pyrites was formed after the rock, and the gold was doubtless introduced simultaneously with the formation of the pyrites.

It is, in fact, far more probable that whatever gold the sea may contain was dissolved from the land, than that the gold on the land was derived by precipitation from the sea.

### *Igneous Rocks as a Source of Ores.*

The igneous rocks are natural sources of iron and its allied metals, for iron is an essential constituent, often to a considerable extent, of the basic igneous rocks. Iron, moreover, is a material which, in the ample time available for ore formation, is easily rendered soluble by natural agencies. Hence the weathering of basic igneous rocks gives an ample supply of iron. It is removed in solution, and re-deposited in the films of rust, which colour red sandstones, and yellow sands and loams. Iron is the most widely diffused of all colouring matters; but rocks in which it may be conspicuous as a pigment may be of no use as an ore. A deposit is of no commercial value as an iron ore unless it contains at least 30, and usually from 50 to 60, per cent of iron. But the agencies that have leached out the iron from igneous rocks, and with it painted our landscapes, continue their action, and concentrate the iron as a serviceable ore.

Thus, the precipitation of iron carbonate by organic agencies in swamps, in lagoons, and along muddy shores, forms beds of clay ironstone, such as the black band ironstones associated with our coal measures, the marlstones of the Lias, and the ores which, in Roman and mediæval times, maintained the iron industry of the Weald.

Such ores are deposited contemporaneously with the rocks in which they occur; but other iron ores have been formed by the infiltration of iron salts into pre-existing

rocks. Thus have been formed the masses of valuable kidney iron ore in the limestones of the North of England. They have been formed where a bed of limestone is covered by a sheet of sandstone stained red by iron oxide. Rain-water, charged with carbonic acid from the air, or with organic acids derived from the decay of plants, percolates through the red sandstones, removes the iron as a soluble carbonate, and carries it down into the underlying limestone. Here the soluble iron salt is acted on by the limestone, some of which is removed in solution, and iron oxide precipitated in its place; and thus the masses of kidney ore are slowly formed, and grow at the expense of the surrounding limestone, as descending waters nourish them with fresh supplies of iron.

The distribution of such ores is limited by two factors. They are limited in area to localities where there was once an overlying, permeable, iron-stained bed to supply the iron; and they are limited in depth by the thickness of the limestone, and that to which water can descend through that rock, before the precipitation of all its iron.

The great deposits of hæmatite in the Lake Superior region, which have given the United States its supremacy in iron production, were, according to Van Hise, similarly formed by descending oxygenated solutions, carrying down iron from beds of iron carbonate. As the oxygenated waters necessary for this process cannot descend to any great depth, it is probable that the main mass of these ores will be limited to the depth of 1000 feet.

The beds of clay ironstone formed as contemporary deposits may, on the other hand, go down to great depths, when sunk in folds beneath thick beds of overlying sediments. The depth of such ores is a simple problem in stratigraphical geology, and the limit to which they can be worked is determined only by the cost of mining.

These iron ores derive their materials from igneous rocks indirectly; but there are some iron ores of direct igneous origin. They have been formed by the segregation of the metallic constituents of a molten magma into masses, or into bands along the cooling edges. The existence of such primary ores is indisputable; but their amount is still largely in doubt. They include masses of magnetite, and also ores of chromite, and according to some authorities, masses of copper pyrites, and of nickel-bearing pyrhotite, and even cassiterite. There is no reason why these segregations should not form at any depth at which molten rocks consolidate; for both the pressure and heat would facilitate their formation, by allowing the molten work to cool so slowly that the segregation can collect the metallic constituents from a vast bulk of rock. Such igneous segregations usually occur in scattered patches; and it is only where they have been formed on the cooling margins of the rock that we have much clue to their distribution. But these ores are of secondary importance; because iron ores do not pay to mine at great depths; and it is only for iron ores that this igneous origin is conclusively established. There is no equal reason for regarding ores of such metals as copper, lead, zinc, gold, and silver as derived from igneous rocks.

The arguments for regarding igneous rocks as the source of ores in general, are their constant companionship and the frequent occurrence of traces of various metals in igneous rocks. Neither fact seems to me convincing. The frequent association of igneous rocks and ores is natural, for the intrusion of the igneous rocks supplies the heat, and makes the fractures necessary for ore formation. In regard to the second argument, it is true that minute traces of various metals have been detected in many igneous rocks, but usually in those of mining fields. It is very doubtful whether the metals are primary constituents. It is far more probable that they have been introduced after the consolidation of the rock, and at the time of the formation of the associated lodes.

### *The Barysphere as the Source of Ores.*

For most ores we are therefore driven back to the third possible source—the hidden interior of the earth, which is called the centrosphere from its position, and the barysphere on account of the weight of its constituents. This is an ample source of metals, for we may regard the earth as a vast ball of iron, hardened, like a modern projectile, by nickel, and no doubt charged with other metals. The rocks of the earth's crust are the stony slag given off from the cooling metallic mass. The one objection to this source is the great depth of the metallic barysphere; the specific gravity of the rocks at the surface is about 2·5, and that of the earth as a whole about 5·0. At the depth of 100 miles the specific gravity of the rocks is estimated to be about 2·8, or merely that of the basic igneous rocks. But in all probability the surface of the barysphere is not regular; projections from it rise into the lithosphere, and the mining fields probably lie over these projections.

There are areas, such as the Scotch Highlands, traversed by faults of colossal size; and with the rocks intensely metamorphosed and charged with quartz veins, but these veins are not, to use the usual phrase, mineralised; there are enough quartz veins to maintain a large mining field; but, with insignificant exceptions, they are barren. The barysphere may be so far below that the quartz veins have not been charged with metals; whereas in other places, owing to the barysphere being nearer the surface, the veins received metallic, as well as non-metallic, minerals.

### *The Transporting Agents.*

Accepting the barysphere as the source of metals, we have to consider the possible agencies by which they have been raised to their present level.

Iron has been brought to the surface of the earth by the intrusion of igneous rocks from the deeper parts of the lithosphere; and some quartz veins are also of igneous origin, having been formed as intrusions of molten rock. But these igneous quartz veins are barren, probably because they were too hot to be a suitable medium for the deposition of metals.

The great majority of ores have been formed by percolating water, as is shown by their arrangement in mass, by their microscopic structure, and by the minerals associated with them.

The introduction of ores in solution is indicated by what is known as "crustification"—their deposition in layers along the two walls of an ore-filled fissure; also by the frequent occurrence of geodes—cavities filled by the slow infiltration of material through cracks; also by the association of ores with such minerals as calcite, which are of aqueous origin, and the rarity of the typical minerals of igneous rocks, such as the felspars and the pyroxenes; and when lodes contain minerals, such as quartz or mica, common to both igneous and sedimentary rocks, the varieties present are those deposited from solution or formed by the re-crystallisation of materials by crushing along fractures. Ores, of course, occur in igneous rocks; but in such cases they have usually been introduced in solution, and have replaced the original minerals.

### *The Descent of Meteoric Water.*

The formation of most ores by water is now universally accepted, so their distribution in depth is controlled by the distribution of underground water. There are two sources of subterranean water. The first is the rain, which supplies the meteoric water. Some of this water runs off in rivers to the sea; another part of it, sometimes the whole, is restored to the air by evaporation, and the rest of it disappears by percolation underground.

The amount of this percolation seems to me to have been greatly exaggerated in the past. The amount lost by evaporation has been under-estimated, and the rocks have therefore been regarded as far more permeable than they really appear to be. This exaggerated estimate of the descent of the surface waters has been due in the main to three ideas.

1. An under-estimate of the amount of water available from other sources for the supply of deep wells. It was necessary to believe that a large percentage of the rain

must percolate underground, and that rocks are very permeable, so long as the deep artesian wells of arid regions were regarded as maintained by the rainfall on the distant hills, as when the flowing wells of lower Egypt were held to be nourished from the mountains of Darfur, and those of Central Australia by the rains on the distant Queensland Hills.

2. That water could descend by capillary action to great depths, even against high internal pressure, was maintained on the basis of an experiment by Daubrée. He inverted a vessel of water over a slab of porous rock, forming the roof of a cistern filled with high pressure steam. The water percolated downward in spite of the upward pressure of the steam; and hence it was claimed that capillarity could suck water downward against the resistance due to the earth's internal heat. But this experiment, as shown by Fisher and Kent, proves nothing, as the movement was toward a free air space, and there is no free air space in the earth corresponding to the cistern in Daubrée's experiment.

3. The third argument for the descent of the surface waters to great depths is based on the hydrodynamic principle, invoked by Van Hise, that a current of water will use the whole area of any channel open to it. If a stream of water be allowed to enter a deep trough, the current does not flow in a straight line from the point of inflow to the exit, but it slowly spreads downwards and upwards till the whole of the water in the trough takes part in the movement. Similarly, according to Van Hise, water percolating downwards at one place, and re-discharged elsewhere in springs or wells, is not confined to the direct line between the two places, but it spreads sideways through a great width of country, and sinks downwards to the greatest available depth. Hence, meteoric water should be universally diffused through a zone at a shallow depth below the surface. According to this conception the whole of one zone of the earth's crust is saturated by a great subterranean sea; and as its waters would be superheated, they would have great solvent powers, and being universally diffused, they would come in contact with all the metallic grains that may occur scattered through this zone of the earth's crust.

But the universal existence of this subterranean sea seems to be abundantly disproved by the evidence of many deep mines and wells. In Bendigo, *e.g.*, the ground water is confined to the surface zone, below which the rocks are dry, except where the levels happen to tap a spring of hot alkaline waters, which are probably of plutonic and not of meteoric origin. They are waters given off from the cooling magma of the earth, and belong to the same category as the fluids that, scattered in innumerable microscopic cavities, give quartz its milky whiteness and form the vast steam clouds, when, through a volcano, molten rocks reach the surface of the earth. These hot waters are therefore sometimes called magmatic on account of their origin from the rock magma of the interior, or juvenile, by Professor Suess, as they are making their first appearance on the earth's surface, or plutonic from their deep-seated origin.

This plutonic water answers all requirements for a depositor of ores. It is coming from the proximity of the metalliferous interior of the earth; it is superheated water —so it is a ready solvent of materials which are insoluble in a less heated water; and it is usually alkaline, and therefore is the readiest solvent of metallic sulphides—the primary condition of the vast majority of ores.

*Changes in Plutonic Waters during their Ascent.*

From whichever source the water comes, it is obvious that aqueously deposited ores must be limited to the depth at which water exists and works; and the range of ores of economic value depends upon the conditions which govern the precipitation of metals from underground solutions. Water, although its constituents may come from vast depths within the interior, is limited to a depth of perhaps only six or seven times the depth of existing mines. The lower limit is due to the internal heat of the globe, which increases from the surface at a rate which may be taken as 1° F. for every 55 feet of descent. This is the traditionally accepted average; and the conditions are too uncertain to make it worth while at present to re-average it. Now water cannot exist at a temperature higher than its critical-point, 687° F. At the assumed rate of increase, that temperature would occur at an average depth of about 37,000 feet; the depth is probably much less in the neighbourhood of igneous rocks and in areas of recent volcanic action; and it may be much lower in ancient rocks in areas which have long remained geologically undisturbed, as, *e.g.*, in the Transvaal.

The figures that can be quoted are only rough approximations, and they will vary in different fields according to the conditions of increase of underground temperature.

At depths below about 37,000 feet, the temperature would be above the critical-point of water, which therefore could not exist as such. Its elements would be given forth as separate gases from the slowly cooling magma; the gases would rise, and having passed into a zone with a temperature below the critical, would combine to form water. This water would be at temperatures far above the normal boiling-point; but it would be kept liquid by the immense pressure of the overlying rocks. This water, owing to its tension, would tend to force its way to the cooler areas through any lines of passage open to it. They will be minute capillary passages, as nothing else could exist at such depths. Nearer the surface the pressure is less, so the spaces will gradually increase in size, and in them the water will collect and continue its upward flow. At length, it would reach a level, somewhere about the average depth of 18,000 to 20,000 feet, where the temperature would be about 400° F., at which water has its maximum capacity for solution; up to that level the water will be steadily dissolving materials, but above it the water will begin to deposit the material which it has brought with it from greater depths. The water has left the zone of accumulation, and has reached that of deposition.

According to the mode of deposition, there are three main types of ores:—

1. The steady ascent of the solution carries it continuously to regions of less and less pressure and of lower temperatures. Both changes favour deposition, and as the changes both in pressure and temperature are gradual, the material will be deposited continuously and fairly uniformly over a great vertical range.

2. A more rapid and patchy deposition occurs where the solution happens to come into contact with some rock, such as limestone, which decomposes the dissolved salts, and leads to the immediate precipitation of the metals, probably as sulphides.

3. When the solution approaches the surface, the rate of cooling is accelerated, and it may be mixed with surface waters, and thus the balance of the metals is quickly precipitated, and a high grade ore results owing to its deposition in a narrow range.

Hence most lodes have their richest ore bodies on the surface, for the agencies that lead to ore formation tend to rapid precipitation there, as the conditions are more complex and the variations in conditions more sudden.

To be continued).

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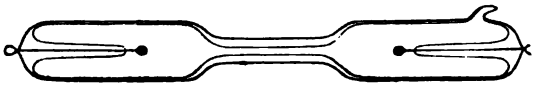
**Preparation of Adipinic Acid.**—Erik Rosenlew.—The author prepares adipinic acid by mixing soda with a solution of cyclohexanone in water, and slowly adding a solution of potassium permanganate, meanwhile agitating with a turbine. The mixture is kept cold during the reaction by means of cold water. After decolorisation is complete the manganese dioxide is filtered off, the filtrate evaporated, and the adipinic acid set free by the addition of concentrated hydrochloric acid. The crystals thus separated out are re-crystallised once from hot water.—*Berichte*, xxxix., No. 10.

THE

## PRODUCTION OF HELIUM FROM RADIUM.*

By Sir WILLIAM CROOKES, D.Sc., F.R.S.

(March 3rd, 1904).—A vacuum tube was made of lead glass of the shape and size shown in the drawing. The electrodes were platinum-wires, each inner end was curled into a loop, and on each loop a bead of radium bromide was fused. The tube was well exhausted, and a one-inch spark from an induction coil passed through. A considerable quantity of carbon dioxide was evolved at



first. This was pumped out, and the spark again passed, a condenser now being intercalated. More gas was evolved, and a sharp line spectrum temporarily made its appearance, but it was too faint for measurement. Carbon dioxide again was seen, and was removed by pumping.

The tube was well heated, exhaustion being continued; helium could not be detected at any pressure, but a sharp line made its appearance at about λ 569.

(June 30th, 1904).—After about four months the tube was again examined with a one-inch spark.

Owing to the great dispersion, the light in the capillary tube was not strong enough to show the spectrum except by flashes, but there was no doubt as to the presence of a sharp yellow line. In order to separate helium and sodium lines a spectroscope was used that easily separated the yellow sodium lines, and fitted with measuring apparatus for getting wave-lengths. Sodium light was sent into the instrument from a spirit flame, and the index was set accurately on the sodium line, $D_2$ (λ 5890·2). The spark was then passed, and the yellow line of the capillary tube was seen to fall decidedly on the more refrangible side of $D_2$, the distance separating them appearing to be about twice as much as that between the two sodium lines.

A stronger spark was employed, and now I was able to see the yellow line of the tube at the same time as the sodium lines of the spirit-flame. After some time the capillary tube became hot, and then sodium from the glass appeared, the three lines being visible simultaneously. Measurements were taken of the wave-lengths of the lines as follows:—

$D_1$ = 5896·2
$D_2$ = 5890·2
$D_3$ = 5875·9 (helium)

The green line of par-helium was also seen, but it was too faint to measure.

The yellow neon line at 6266·7 could not be seen.

The radium was heated to redness with a spirit-flame, but it only had the effect of making the helium line a little brighter, and did not introduce any fresh lines. The line formerly seen at 569 could not be detected.

## RADIUM.

### Letters from "The Times."†

(Continued from p. 127).

(August 18, 1906).

Sir,—The discussion which has taken place on the origin of the earth's heat leads one to question how far we are entitled to gauge the amount of heat set free by the disintegration of radium in the earth's crust.

Our laboratory experiments certainly show that radium in giving off heat, and the atomic alteration of the substance would be quite sufficient to account for it. I had 5 m.grms. of radium preparation, which was stated to be of 800,000° of activity, and it was quite possible to show that this, or rather the enclosure containing it, was perceptibility hotter than a similar enclosure containing an equal weight of any other kind of matter. But here we have the radium concentrated in a small bulk; it has a free surface, and therefore permits of the easy escape of particles, which by their mutual bombardment, or by the bombardment of surrounding surfaces, would give rise to the observed elevation of temperature.

Now, is it possible for the same freedom of action to occur when the radium is disseminated through enormous masses of rock?

One, of course, knows that the total radio-active effect depends upon the actual amount of radium, and not on the concentration; but, as there must be a hindrance to the free movement of the particles, it seems likely that inferences drawn from laboratory experiments may not be exactly applicable to the behaviour of radium imbedded in the earth's crust.

Is not the energy of the α-particle, and consequently its heating value, proportional to the freedom with which it can move, and is not this energy cut down very considerably by even a thin layer of air?

If a small quantity of radium were placed at the centre of a small lead sphere so that there was no space between the radium and the surrounding lead, would the latter show any rise in temperature?—Yours faithfully,

W. A. Douglas Rudge.

Woodbridge School, Suffolk, Aug. 15.

Sir,—The argument used to support the proposition that the salts of radium and the element itself disintegrate—namely, that it gives off helium—would be more satisfactory if helium did not already exist in the surrounding atmosphere. Is it not just possible that radium sorts it out from this atmosphere? And absorption of gases generally means rise of temperature. But of the mechanism of absorption and the sorting action accompanying it we practically know nothing, not even excepting the case of our familiar friend charcoal.—Your obedient servant,

James C. Richardson.

19, Claremont Square, Aug. 16.

(August 20, 1906).

Sir,—In your yesterday's issue I see letters of Sir Oliver Lodge and Mr. R. J. Strutt, replying to my letter to you of August 9 regarding radium.

After a kind personal reference to myself, Sir Oliver Lodge says, "But it is also known that" Lord Kelvin's mind "has not always submitted patiently to the task of assimilating the work of others by the process of reading, and our hope has been that before long he would find time and inclination to look into the evidence more fully." I am quite sure my old friend Lodge could not wilfully be unjust to me, but I do not think he knows how carefully and appreciatively I have done all I could by reading, and by personal intercourse with many of the chief workers in the field, to learn experimental results and theoretical deductions regarding radio-activity, ever since its discovery ten years ago by Henri Becquerel. I scarcely think any other person has spent more hours in reading the first and second editions of Rutherford's "Radio-activity" than I have.

Both Lodge and Strutt refer to the slowness of the extraction of helium from radium, in the process hitherto followed; and there seems to be good reason to believe that this slowness is essential. Strutt says, "If all helium has been removed from a sample of radium, it is found that, after an interval, a further supply can be extracted." The last clause shows that the initial "if" was wrong, and that some helium remained in the modified sample of radium. This view is thoroughly in accordance

* Abstracts from Laboratory Note-book.

† These Letters from *The Times* have reference to the Discussion on "Radio-activity and the Internal Structure of the Earth," at the York Meeting of the British Association (Section A), August 6, 1906.

with Rutherford's second edition (1905) p. 284, in which it is suggested that "uranium, thorium, and radium are in reality compounds of helium"; and, more particularly, that radium (atomic weight 225) may be a compound of four atoms of helium (atomic weight 4 × 5) and one atom of lead (atomic weight 205).

As to the suggestion, made first, I believe, by Sir George Darwin about three years ago, and favourably received by Rutherford, Strutt, and others, that our present underground heat, and sunlight, and sun-heat are due to radium, I must, for the present, limit myself to two sentences:—1. Radium alone is quite insufficient, its duration as a source of energy being estimated by Rutherford (2nd edition, p. 458) as not more than a few thousand years, ("The average life of radium is 1800 years"). 2. The suggestion that in uranium, thorium, actinium, and other matter capable of being "transformed slowly into radium," we have at least a million times as great a store of energy as we may think we have in radium, practically available for sun-heat and underground heat, is not validly supported by any experimental evidence hitherto published.—I remain yours faithfully,

KELVIN.

Aix-les-Bains, Aug. 16.

(August 21, 1906).

SIR,—I am glad to have contributed towards eliciting Lord Kelvin's views on this subject. Those interested will no doubt judge for themselves whether or not the precautions adopted by Ramsay and Soddy, Himstedt and Meyer, and Curie were such as to make it certain that helium is continuously evolved from radium, as those writers supposed.

As to the internal heat of the earth, Lord Kelvin quotes the generally accepted conclusion that the life of radium is limited to a few thousand years. From this he argues that the radium now in existence has not been there long enough to heat the earth to its present high internal temperature. To this I reply that it is true that the actual radium now in existence has not done the work throughout, but that the supply of radium in the earth is maintained at a constant level by the production of fresh radium by uranium, contained in a small proportion in the rocks. Lord Kelvin, anticipating this reply, expresses his dissent from the view current among workers on radio-activity, that radium is continuously produced by uranium. I should like to ask a simple question. Lord Kelvin disbelieves that radium is being generated from any parent substance. How does he explain the existence of radium in the earth at present? On his own showing the identical radium now existing has not been there long. Is he prepared to assume that it was miraculously created in comparatively recent times?—I remain yours,

R. J. STRUTT.

40, Portman Square, W.

(August 22, 1906).

SIR,—Lord Kelvin's name is one which, during my officially "student" days and subsequent quarter of a century's college lecturing, I have taken not in vain but in earnest more frequently than that of any other physicist living or dead. Consequently, I trust that on the personal or biographical side general readers will take their cue from your leading article of last Saturday; but it would be wise for them to consider the scientific matters at present in debate as open questions to be settled by further investigation and discussion of laboratory facts, without undue insistence on weight of authority. I know that Lord Kelvin—from whom a further letter appears in your issue to-day—will be in accord with this recommendation, and I take the opportunity afforded by this little holiday correspondence to assure him of my profound and affectionate regard,—I am, Sir, faithfully yours,

OLIVER LODGE.

The Hermitage, Bletchingley, Surrey, Aug. 20.

(August 24, 1906).

SIR,—In his letter published by you yesterday Mr. Strutt refers to experimenters who "supposed" that their work proved continuous evolution of helium from radium, and implies that I contest this conclusion. I never contested it. On the contrary, I feel that "supposed" is too weak a word. In fact, they found helium gradually beginning to show its presence in emanations from solutions of radium which at first showed no helium to the spectroscopic test.

Mr. Strutt, in his letter published yesterday, says, "Lord Kelvin expresses his dissent from the view current among workers on radio-activity that radium is continuously produced by uranium." This is an inadvertent misinterpretation of the last sentence of my letter in *The Times* of August 20, in which I only said that a particular suggestion going far beyond that view "is not validly supported by any experimental evidence hitherto published." We know nothing by experiment of the energy-value of the radio-activity found in igneous and in sedimentary rocks by Strutt and other trustworthy and able workers. The suggestions of Mr. Douglas Rudge on this subject in *The Times* of August 18 are important, and worthy of careful consideration.

Mr. Strutt asks me "a simple question"; how do I explain the existence "of radium in the earth at present"? My answer is—by concourse of atoms, and by interatomic motions, from a time when the ponderable matter of the solar system and the stars existed as separate atoms, scattered through the ether, and moving with velocities probably much less than the present velocities of stars through space. It seems to me fairly probable that the atoms of helium, and (?) lead, constituting the present radium, were, in later times, forcibly grouped together, among all the crystallisations which have constituted granite from a previously liquid earth.

I must apologise to you for trespassing on your space with mere guesses regarding prehistoric time. Coming down to the time of human history, I think we may agree with Mr. Douglas Rudge, and others who have suggested similar views, that a molecule of radium embedded in the earth's crust, under enormous pressures, probably has its constituent atoms safely protected against the explosive flyings asunder by which they produce the heating effects discovered in our laboratories.—I remain yours faithfully,

KELVIN.

Aix-les-Bains, Aug. 22.

(To be continued).

## NOTICES OF BOOKS.

*Researches on Cellulose.* II. (1900-1905). By CROSS and BEVAN. London, New York, and Bombay: Longmans, Green, and Co. 1906.

THE period (1900-1905) covered by this book has seen the publication of much important work upon the constitution of cellulose, and the authors' review will be welcomed by all interested in the subject. The text is arranged excellently, and the appearance of the book marks a distinct advance in our knowledge of the nature of cellulose. The most important articles and papers on the subject which have appeared during these five years are either reprinted in full or else abstracted and then criticised by the authors, who, while they preserve a perfectly open mind upon disputed questions, and discuss the various views put forward without bias, are well qualified to be regarded as experts whose opinion is of the utmost value. The text is divided into three sections; the first gives a general *résumé* and forecast, discussing cellulose first as a typical colloid and then as a chemical individual, and finally considering some aspects of structural forms and dimensions of the celluloses. The second section gives an account of original investigations from 1900 to 1905, arranged as

explained above, and grouped as reactions of synthesis and reactions of resolution and decomposition, and the last part of the book is devoted to a short dissertation on technical progress in cellulose industries, and gives a very interesting summary of recent developments in this branch of technology.

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*A List of Official Chemical Appointments.* Compiled by Richard B. Pilcher. London: The Institute of Chemistry. June, 1906.

This list of Chemical Appointments will serve a useful end if only as a guide for the increasing number of science students whose tastes would lead them to adopt chemistry as a profession, and who have not hitherto been able to obtain in a convenient form information as to the posts which might be open to them. Moreover, analytical and consulting chemists will find the publication of some value, and it will doubtless receive a cordial welcome in the scientific world. It contains lists of professional and teaching posts, and also appointments open to chemists in the various Departments of State in Great Britain and the British Colonies and Protectorates, together with, in many cases, summaries of the Acts under which the officials are appointed. For completeness sake some appointments are included which are not strictly chemical, but are connected with such subjects as agriculture, metallurgy, &c., and although every effort has been made to make the lists as comprehensive as possible, the compiler claims indulgence for errors or omissions, which will be granted readily as the book is the first of its kind, and is to be regarded as the forerunner of later and possibly fuller editions.

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*London Matriculation Directory*, No. XLIII., June, 1906. London: University Tutorial Press.

The guides to the Matriculation Examination of the University of London issued by the Tutorial Press are perhaps too well known to need recommendation. This volume contains the papers set in June, 1906, with comments upon them and full solutions, suggestions as to profitable courses of study, and the complete syllabus, both of matriculation and of some of the higher examinations of the University. The general hints and articles upon the choice of text-books contain some sound advice, and the book will be found invaluable, especially by private students who intend to enter for the examination.

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*Zeitschrift für Chemische Apparatenkunde.* ("Journal of Chemical Apparatus"). Edited by Ph. Schuberg. Berlin: Rudolf Mückenberger.

This journal, which was first published at the end of last year and appears twice a month, will be specially appreciated by two classes; in the first place, those who are engaged in research work will find that a study of its pages will repay them, for it will save them much time in their search for the best and most modern methods of solving mechanical problems; and secondly, directors of laboratories and chemical engineers will gleam some useful hints from it. Thus, the discussion of the fitting up of some typical new laboratories is made a special feature, and the illustrations and descriptions of the new Institute of Technical Chemistry belonging to the High School at Berlin, for instance, are really valuable. Moreover, in reading periodical literature the chemist constantly comes across allusions to, or recommendations of the use of, various apparatus or materials with which possibly he is not familiar, and he will find it a great convenience to be able to look up information about them in this journal, which publishes useful articles upon such subjects as cryptol, the butyrometer, &c. While the original articles appear to come up to a high standard in every respect, the abstracts of papers in various periodicals dealing with mechanical appliances and contrivances are almost equally valuable, and the new journal will no doubt continue to receive the support it well deserves.

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*Lists of Spectroscopes and Spectroscopic Accessories and of Echelon Diffraction Gratings.* London: Adam Hilger, Ltd. 1906.

The first of these two catalogues contains specifications of spectroscopes for general work and for special purposes; microspectroscopes and diffraction gratings, polarimeters, micrometers, and all kinds of accessories. The list is fully illustrated, and the latest improvements in the manufacture of spectroscopes are embodied in the instruments of this firm, which is well known throughout the world for the thoroughness of its workmanship. A price list of vacuum tubes and accessories is also included in the catalogue. List B contains details as to prices, &c., of the Michelson Echelon Diffraction Gratings, which the same firm has been manufacturing since 1899, and have now brought to a high state of excellence. The Auxiliary Constant Deviation Spectroscopes for use with Echelons are also described, special attention being called to the Hilger Wave-length Spectroscope, which presents some novelties in construction, and which has been found highly satisfactory in use.

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*Monumenta Pulveris Pyrii.* By Oscar Guttmann, M.Inst.C.E., F.I.C., F.C.S. London: The Artists' Press. 1906.

This beautifully bound collection of reproductions of ancient pictures concerning the history of gunpowder, of which only a very limited number of copies has been issued, is a work of both scientific and artistic value which is quite unique of its kind. The early history of a scientific industry cannot fail to be peculiarly interesting to present-day workers, and when it is illustrated by such a series of pictures, its value is increased in proportion to its vividness. The illustrations go back to the time of Roger Bacon, of whom there are two beautifully executed early portraits, and of Berthold Schwarz, whose labours according to the ancients were evidently directed by a horned and hoofed adviser. All the first exceedingly primitive methods of refining saltpetre are depicted, as well as the preparation of charcoal and sulphur, the pictures of the early mechanical appliances being specially interesting. Among all the beauties of the illustrations it is difficult to pick out the best, but attention may be called to the frescoes in the former monastery of St. Leonardo in Leccetto, near Siena, which are excellently reproduced, and which contain representations of some of the earliest guns. The illustrations, as they began with Bacon and Schwarz, conclude with portraits of modern men of note, whose names have been made famous by their work on explosives. The explanatory text is written in three languages, English, French, and German, and the author has evidently thrown his whole heart into the production of this beautiful work of art.

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*Zeitschrift für Angewandte Mikroskopie.* ("Journal of Applied Microscopy"). Edited by G. Marpmann. Vol. XI. Leipzig: Hygienischer Verlag. 1906.

The eleventh annual volume of this journal contains the monthly parts from April, 1905, to March of the present year. The chief feature of the publication is the prominence given to classified abstracts of papers dealing with clinical chemistry, the microscopical investigation of foods and feeding stuffs, technical products, micro-organisms, &c., which have appeared in other periodicals, and which are noticed in some cases at considerable length month by month. The majority of the original articles deal with subjects of biological interest; one very useful series consists of contributions to practical microscopy, and contains a good many practical hints and suggestions, while an article on radium and its action upon the eyes gives an interesting account of the results of experiments with radium bromide.

# CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxliii., No. 7, August 13, 1906.

**Preparation of Pure Barium from its Sub-oxide.**—M. Guntz.—When a mixture of magnesium powder and BaO are heated in an iron vessel enclosed in a porcelain tube to 1100° for an hour, the baryta changes its appearance and becomes blackened. This result is due to the formation of a sub-oxide, $Ba_2O$. When, however, a mixture of BaO and one-tenth its weight of Al is heated *in vacuo* to 1200°, a crystalline metal is obtained, containing 98·8 of Ba, which a second distillation *in vacuo* renders absolutely pure. This preparation of the metal is due to the intermediate formation of the sub-oxide $Ba_2O$, the dissociation of which produces the metal.

**Aromatic Azocyanamides.**—P. Pierron.—Though amides have no tendency to react on diazonium salts, the monatomic cyanamides do possess—probably by virtue of their more acid character—the property of forming compounds with diazonium salts. From these result, by their nitrogen substitution, a union with the benzenic or naphthalenic series. The author reacts upon the aromatic cyanamides with diazobenzol chloride. From the mixture thus obtained he extracts a yellowish red precipitate, which is the primary paramidoazoic cyanamide,—

$$C_6H_5—N=N—Cl+CN—NNa—C_6H_5= \\ =C_6H_5—N=N_{(1)}—C_6H_5—NH_{(4)}—CN+NaCl.$$

By similar methods he prepares various other compounds.

**A Property of Diastases.**—J. Duclaux.—The name diastase is often used to denote two different things. Properly speaking, amongst diastases the majority (almost all) are colloids. The author has already shown that a colloid is composed of two parts, of which one—in bulk the larger—does not enter into any reaction, but simply serves to support the other (or active) part. After an exhaustive study of this latter portion, the author proves that it is essentially variable; it changes, not only by the action of salts, but by the simple addition of water, and the diastasic actions of metallic salts are attributed to this portion of the salt.

**Copper Steels.**—Pierre Breuil.—Already noticed.

# MISCELLANEOUS.

**The Chemical Laboratory at Wiesbaden.**—During the Summer Term, 1906, the Chemical Laboratory Fresenius was attended by 41 students. Of these 30 were from Germany, 4 from England, 2 from Holland, 2 from Russia, 1 from Hungary, 1 from the United States of America, and one from Brazil. There were three assistants in the Instruction Laboratory, and twenty-seven in the Versuchsstationen (private laboratories). To the teaching staff of the Institution belong the Directors, Geh. Regierungsrat Prof. Dr. H. Fresenius, Prof. Dr. W. Fresenius, Prof. Dr. E. Hintz, and also Prof. Dr. med. G. Frank, Dr. L. Grünhut, Dr. R. Fresenius, and J. Huber (Architect). The next Winter Term begins on October 15th. During the Summer Term, 1906, besides the scientific researches, a great number of analyses were undertaken in the different departments of the Laboratory (Versuchsstationen) on behalf of trade, manufacture, mining, agriculture, hygiene, justice, and government.

Session Commences Wednesday, Sept. 26.

**BIRKBECK COLLEGE,**
Breams Buildings, Chancery Lane, E.C.

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| PHYSICS .. .. .. .. | A. GRIFFITHS, D.Sc. |
| MATHEMATICS .. .. | E. H. SMART, M.A. |
| BOTANY .. .. .. .. | V. H. BLACKMAN, M.A. |
| ZOOLOGY.. .. .. .. | H. W. UNTHANK, B.A., B.Sc. |
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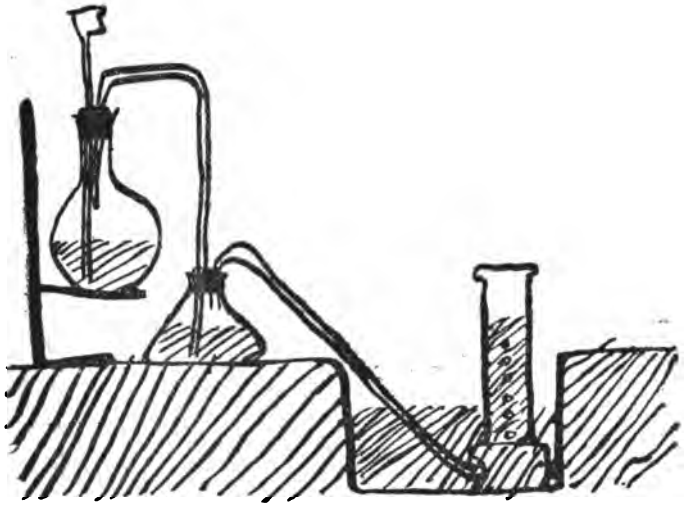

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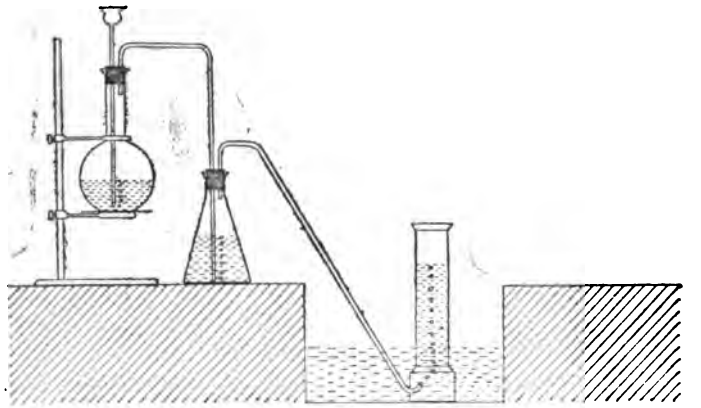

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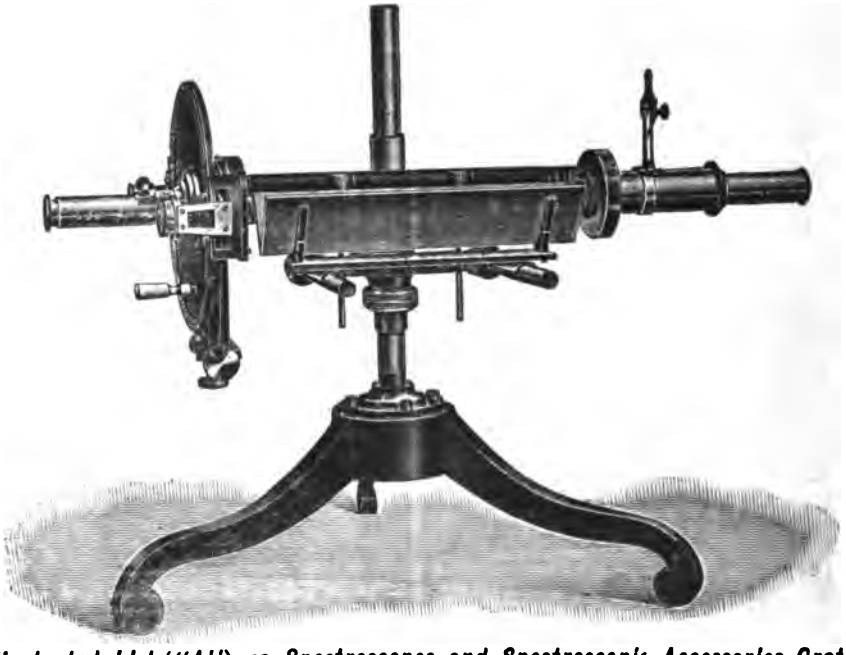

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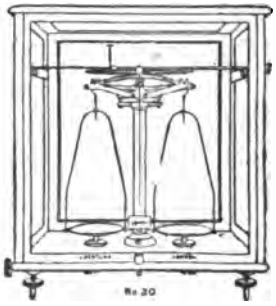

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VOL. XCIV., No. 2444.

## NOTE ON OPALESCENCE IN FLUIDS NEAR THE CRITICAL TEMPERATURE.*

By SYDNEY YOUNG, D.Sc., F.R.S., Trinity College, Dublin.

THE phenomenon of opalescence at and near the critical temperature has been observed by Travers and Usher under exceptionally favourable conditions, owing to the great width (8 to 10 m.m. internal diameter) of the tubes they employed. The opalescence is, however, distinctly visible, and can be studied in much narrower tubes, such as those (0·15 m.m. internal diameter) used in my own investigations.

The experiments of Travers and Usher were carried out, for the most part, in such a manner that the total volume of the substance investigated remained constant, while the temperature rose very slowly. In my experiments, on the other hand, the substance was kept at its critical temperature,† and the volume was altered (usually diminished) by equal stages. The opalescence was always seen, but notes of its position and character were only made with a few substances—isopentane and normal pentane, hexane, and octane.

My observations—mostly unpublished—may be regarded as supplementing and, so far as a comparison is possible, confirming those of Travers and Usher, and the following generalisations may be deduced from them :—

1. When observations are made at the critical temperature (Cagniard-Latour temperature) at a series of diminishing volumes, no opalescence is visible so long as the volume exceeds a definite limit. When this limiting volume is passed, a slight opalescence appears at the bottom of the tube; that is to say, just over the mercury; at still smaller volumes the opalescence or mist becomes denser, and extends further up the tube. Near the critical volume the mist is very dense, especially near the middle: it may extend all through the tube, or the tube may appear clear either at the top or both at top and bottom. When the volume is further reduced, the mist disappears below, but becomes dense above, and on further compression the clear part extends upwards and the remaining mist at the top becomes less dense, and finally disappears at a definite volume.

When observations at the critical temperature are made at a series of increasing volumes, there is a tendency for the mist to be lower down in the tube than when they are made during compression. This tendency may probably be explained by the fact that each expansion causes a temporary slight fall below the critical temperature, and, consequently, a very slight condensation from the critical to the liquid state (in three cases it was noted that the meniscus was actually seen for a moment). Some little time would be required for equilibrium to be re-established after such a disturbance of the density, and it may be that the time actually allowed—one or two minutes at most—was insufficient. On the other hand, during each compression, there is a very slight rise of temperature, but this does not cause any change of state or disturbance of density.

2. When observations are made at a temperature slightly higher than the critical temperature, the mist is not only much less dense, but the range of volume over which it is visible is more restricted.

3. The limits of volume between which mist is visible at the critical temperature seem to be nearly the same for the four paraffins examined (about 1·17 or 1·18 to about 0·87 or 0·88, taking the critical volume as unity in each case).

One conclusion drawn by Travers and Usher from their experiments is that "the opalescence is confined to that phase which is decreasing in volume through movement of the dividing surface, or, at least, is most intense in that phase." It happens, however, that in their experiments, whenever the liquid phase was small at first, it diminished, and when large at first it increased; and it may be doubted whether the above relation would be found to hold good for a phase which was large but decreasing in volume; for example, under the following conditions:—(*a*) Constant volume and slowly falling temperature; (*b*) constant temperature and the total volume either large but decreasing, or small but increasing.

It seems probable from my experiments that the position of maximum opalescence really depends on the mean specific volume of the substance, being near the bottom when the volume is large, near the top when small, and near the middle at intermediate volumes.

This question, although it does not affect the main conclusions arrived at by Travers and Usher, seems to be of sufficient interest to repay further investigation.

* A Paper read before the Royal Society, June 21, 1906.

† In the case of normal pentane the "Cagniard-Latour temperature" and the "critical temperature" were found to be identical or at least indistinguishable (*Trans. Chem. Soc.*, 1897, vol. lxxi., p. 446).

## A METHOD OF DETERMINING INDIGOTIN.*

By W POPPLEWELL BLOXAM.

A CRITICAL examination of the various methods which have been proposed for the analysis of indigo was first undertaken.

The first consideration was the preparation of pure indigotin for use as a standard. Sublimation under diminished pressure proved to be the simplest method of obtaining pure indigotin. Indigotin was also obtained by re-crystallisation from nitrobenzene. Indigo "B.A.S.F. rein" was used as a starting-point for both these operations; by the former method 100 grms. can easily be prepared in a day, whereas the latter only gave a yield of some 30 grms. after a week's work.

The sulphonation of indigo and titration of the product with an oxidising or reducing agent is the basis of all practicable methods of analysis.

The oxidation with potassium permanganate of the sulphonation product of crude indigoes gives only comparative results and not the true indigotin content of the samples, owing to the oxidation of the various impurities always associated with natural indigo. Two reagents have been suggested for the precipitation of these impurities; barium chloride by Rawson, and calcium carbonate (in excess) by Grossmann. Neither of these methods is satisfactory, for although some impurity is precipitated, there still remains in solution sufficient to upset the titration, and a still more important objection to both these methods is the fact that a certain amount of indigotin is always precipitated as the barium or calcium salt of the sulphonic acid. A closer investigation into these methods was made by preparing in a state of purity the mono-, di-, tri-, and tetrasulphonic acids, and studying the properties of their barium and calcium salts. The results confirmed the observations made above.

The reduction of the sulphonated indigo by titanium trichloride as proposed by Knecht was also open to objection, but by the application of various improvements in the experimental conditions this method proved to be very valuable for the titration of pure indigotin. It is little better than the permanganate, however, for titration with crude indigo; and if an indigo solution, of the concentration recommended for the reduction by Knecht, be purified by precipitation with an excess of chalk, so great is the loss of indigotin that pure indigotin gives a return of only 50 per cent.

* Abstract of a Paper read before the British Association (Section B) York Meeting, 1906.

In view of these results the idea of precipitating the impurities was abandoned.

Complete success was obtained, however, by precipitating the indigotin and leaving the impurities in solution. This was achieved by the use of potassium acetate. It was found that the quantitative separation of indigotin by this method depended upon the degree of sulphonation. This involved a complete investigation of the effect of different strengths of acid on indigotin for varying times and temperatures.

Sulphonation to the tetrasulphonic acid condition is necessary for the precipitation of a crystalline product; hence the name the "Tetrasulphonate Process."

If 1 grm. of pure indigotin is sulphonated for twenty minutes at 98° C. with 20 per cent fuming sulphuric acid, the tetrasulphonic acid is obtained without loss of indigotin. To obtain the same result with a crude indigo sulphonation with 25 per cent acid for forty-five minutes is necessary. The analysis is carried out as follows:—

100 c.c. of the indigo solution (of 1/500 concentration) are precipitated with 100 c.c. of a solution of potassium acetate (containing 450 grms. of salt in 1 litre of solution). The whole is warmed until resolution is effected, when it is cooled in a stream of running water and then placed in a vessel containing ice and water, and left for one hour. The crystalline potassium indigotintetrasulphonate is filtered off on the pump by means of a Gooch crucible with a well-fitting disc of filter-paper, and washed with an isotonic solution of potassium acetate.

The salt is then dissolved in 200 c.c. of water, and titrated under the improved conditions with potassium permanganate or titanium trichloride. To establish the method it was necessary to isolate the impurities of indigo; this was done by extraction, first with dilute acid and then with pyridine; both the products recovered from these extractions remained in solution after sulphonation and addition of potassium acetate. The accuracy of the process was finally proved by analysing a mixture containing known amounts of pure indigotin and these impurities; such analysis gave the theoretical amount of indigotin. The constitution and properties of the brown impurities extracted with pyridine are now under consideration.

A complete analysis was made of the Pemberandah Factory "Cake" for the season 1903-1904, and the results were calculated back to show the percentage of indigotin obtained from the whole plant. The figures reveal the fact that the efficiency of the present method of indigo manufacture is about 25 per cent of the total indigotin obtainable.* The attention of the Government of India will be called to this wasteful method of manufacture with a view to the introduction of the long-needed improvements without delay.

Clothworkers' Research Laboratory,
University of Leeds.

* The percentage of indigotin contained in the whole plant (ordinary Indian varieties) being taken, as seems reasonable, at 0·6 per cent.

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**Oxidation of Diphenyldiselenide, $(C_6H_5)_2Se_2$.**—M. Stœcker and F. Krafft.—When diphenyldiselenide is treated with nitric acid, the seleninic acid is formed, and with chlorine water the seleno acid. The former is obtained as crystalline needles which explode on heating. From it the silver salt, $C_6H_5SeO_2Ag$, and the barium salt, $(C_6H_5SeO_2)_2Ba$, can be prepared. A well defined hydrate of phenyl selenous acid, $C_6H_5SeO_2H + H_2O$, or $Se^{IV}C_6H_5(OH)_3$, is obtained when the silver salt is decomposed with hydrochloric acid. The silver salt of phenyl seleno acid is obtained by suspending phenyldiselenide in much water, heating to 50°, passing in chlorine, and adding silver oxide; from it the barium salt and the free acid (phenyl seleno acid) can be prepared.—*Berichte*, xxxix., No. 10.

## PRELIMINARY EXPERIMENTS WITH A CYANAMIDE COMPOUND AS A NITROGENOUS FERTILISER.*

By FRANK T. SHUTT, M.A., F.I.C.,
and
H. W. CHARLTON, B.A.Sc.

Of the elements of plant food necessary to return to the soil in order that fertility may be maintained, nitrogen is the most important, for not only is it the most readily dissipated by culture and cropping, but it is the most expensive to purchase in forms suitable for plant nutrition. It is evident therefore that any method which seeks to entrap the unlimited supply of free atmospheric nitrogen and convert it into a nitrogenous fertiliser would be one of great interest to the agricultural world. This will be the more apparent when we remember that "intensive" farming is becoming the order of the day, and that such calls for large amounts of available nitrogen. Further, if it is true that the beds of Chili saltpetre (nitrate of soda, one of the principal sources of agricultural nitrogen) are fast becoming exhausted, an economical process for the manufacture of a fertiliser from the air rich in nitrogen would open up an avenue for the profitable employment of capital.

The fixation of free nitrogen that we have here alluded to has been recently accomplished, though as yet no one of the several processes experimented with have, as far as we know, been sufficiently perfected to make it a commercial success. The source of energy employed to bring about the fixation is electricity, and the product usually sought calcium cyanamide. In the investigation about to be described the calcium and potassium salts of cyanamidocarboxylic acid were used. A sufficiency of these compounds for our preliminary work was kindly furnished by Mr. T. L. Willson and Mr. M. Haff, of the Willson Research Laboratory, Ottawa. The preparation of the compounds is described by Mr. Haff as follows:—

"A mixture of lime and carbon, through which a stream of air is passed, is brought to high temperature in the electric furnace by a suitable current. The mass, when perfectly cold, is lixiviated with cold water, filtered, and the filtrate evaporated *in vacuo*. When the solution is moderately concentrated it is filtered, carbonic acid gas is bubbled through, and the calcium cyanamide is precipitated as a calcium salt of cyanamidocarboxylic acid, $Ca(CN.NH)_2CO_2$.

"To obtain the potash salt, the solution containing diluted calcium cyanamide is treated in the cold with dilute potassium carbonate, filtered, and evaporated *in vacuo* till a concentrated solution is obtained, keeping it warm and bubbling through it carbonic acid. The potash salt ($K.CN.NH.CO_2$) is precipitated in needle-like crystals. The object in using the potash compound is to obtain a fertiliser that will furnish potash as well as nitrogen, and thus double its value as a fertiliser."

The experiments about to be described fell into two series. The first was to ascertain the effect of these compounds on the germination or vitality of certain seeds; the second was to determine the rate at which these compounds were nitrified or rendered available when present in the soil in various proportions.

### *Effect on the Vitality of Seeds.*

It had been observed by investigators in Germany that cyanamide, if applied when the seeds were sown or only shortly before, had a decidedly poisonous effect, retarding germination and in some cases causing the death of the young plants. To verify this and to ascertain if some seeds had a greater resisting power to the action of the cyanamide than others, the following research was made:—The seeds chosen were wheat and peas, representing

* *Transactions of the Royal Society of Canada*, Second Series, 1905-1906, vol. xi., Section III.

starchy and albuminous seeds, respectively. These were sown in porcelain basins containing each 4 pounds of soil. There were in all thirty basins, of which nine were checks and received no cyanamide compound. To secure uniformity of distribution the compounds experimented with were dissolved in water and then applied to the soils —the quantity varying as shown in the subjoined table. All the trials were kept under the same conditions as regards moisture, temperature, &c.

*Effect of Cyanamide Compounds on the Germination of Seeds.*

| M.grms. of nitrogen added per 100 grms. of soil. | Results. |
|---|---|
| *Calcium Cyanamidocarboxylate.* | |
| 0·5, 1·0, 1·8, 2·1, 3·7, 4·2 | Wheat and peas: Germination not retarded and plants not affected. |
| 7·4 | Wheat and peas: Germination retarded; plants slightly affected. |
| 10·4 | Wheat and peas: Ditto, but injurious effects more pronounced. |
| 14·9 | |
| 20·9 | Wheat plants badly affected. Peas, germination very much retarded. |
| 21·9 | |
| *Potassium Cyanamidocarboxylate.* | |
| 28·0 | Wheat: Germination much retarded and plants soon withered. Peas, very few germinated. |
| 29·3 | |
| 41·8 | Wheat: Plants withered and died on reaching the height of a few inches. Peas, vitality of seed so far impaired that none germinated. |
| 41·8 | |
| 1·1, 2·2, 4·5 | Wheat and peas; Germination not retarded; plants unaffected and strong. |
| 9·1 | Wheat and peas: Germination retarded. |
| 13·7 | Wheat and peas: Germination retarded and wheat plants seriously affected. |
| 18·3 | Wheat and peas: Germination much retarded, especially in the case of peas. Plants of both very weak. |

A consideration of the tabulated results will make it apparent that these compounds, save when present in very small quantities, injuriously affect the vitality of the seed. As the amount is increased the toxic effect becomes more and more noticeable, not only in the retardation of germination, but also upon the health and vigour of the young plants. Wheat is better able to resist this action than peas; nevertheless, the wheat plants in the tests containing the larger amounts of cyanamide frequently turned black, withered, and died after reaching a height of 3 to 5 inches.

A careful review of this work led us to conclude that the presence of the cyanamide compounds in amounts equivalent to 5 m.grms. or less of nitrogen per 100 grms. of soil would not prove injurious to the germination of seed. Toxic effects were markedly noticeable, however, with amounts between 10 and 20 m.grms. per 100 grms. soil, while still larger quantities proved fatal. The potassium compound appears to be more injurious in its action on the life of the seed and of the young plants than the calcium salt.

Trials were made with other seeds, but owing to an unfortunate accident the results were rendered useless.

*Nitrification of the Cyanamide Compounds in the Soil.*

The fact having been established that freshly applied cyanamide has a deleterious action upon the seed and young plants, it became a matter of considerable interest to learn what length of time is required to bring about in the soil the conversion of the compounds under investigation into innocuous forms. And in this connection it may be remarked that even if these substances possessed no toxic action on vegetable life, their nitrogen would not be available for plant nutrition until they had undergone nitrification, since practically it is only as nitrates that ordinary farm crops obtain their nitrogen from the soil.

The experiments conducted to ascertain the rate of nitrification were carried on in plots holding five pounds of soil each. The soil throughout the series was uniform, and the estimations of the free ammonia and nitrates were made at stated intervals after the application of the cyanamide. Two pots were used as checks, and to these no cyanamide was added, but their ammonia and nitrates were determined on the same dates as those upon which the rest of the series were examined, so that changes normally taking place in the soil nitrogen could be followed. The methods used for the determination of the nitrogen compounds were those commonly employed in water analysis, and consequently the results may be considered as closely approximating the truth. Throughout the period of trial the soil in all the pots was kept under uniform conditions as regards moisture and warmth. The temperature of the room in which the pots were kept ranged from 65° F. to 75° F.

*Experiment* I.—This consisted of four pots each containing an amount of the calcium compound (37·84 per cent nitrogen) equivalent to an application of 22·5 lbs. per acre of a compound containing 16 per cent nitrogen. The experiment was begun on October 22nd, 1904, and estimations made on December 12th, 1904, and March 21st, 1905.

*Nitrogen.*

| | 22/10/94. | 12/12/04. | 21/3/05. |
|---|---|---|---|
| M.grm of nitrogen added per 100 grms. of soil .. .. .. .. | 0·36 | — | — |
| As ammonia .. .. .. .. .. | — | 0·042 | 1·442 |
| As nitrites and nitrates.. .. .. | — | 0·787 | 0·088 |
| As ammonia, nitrites and nitrates | — | 0·829 | 1·530 |
| As ammonia in check .. .. .. | 0·026 | 0·017 | 0·249 |
| As ammonia, nitrates and nitrites in check .. .. .. .. .. | 0·275 | 0·682 | 1·231 |
| Percentage of added nitrogen converted into ammonia, nitrites and nitrates.. .. .. .. .. | — | 40·8 | 83·0 |

With small applications, as in this experiment, the conversion of the nitrogen of the cyanamide compound into ammonia proceeds fairly rapidly; the second and third stages by which the ammonium salts are converted into nitrites and nitrates are apparently of much longer duration. This would seem to indicate that the organisms instrumental in the production of nitrates and nitrites are susceptible to the toxic action of the compound.

*Experiment* II.—Was conducted upon a portion of the soils used in Experiment I., to which a further application of cyanamide was made, the amount being equivalent to 683 lbs. per acre of a compound containing 16 per cent nitrogen. The method of procedure was similar to that just described. The experiment was begun on March 21st, 1905, and subsequent determinations of the nitrogen compounds were made on March 28th, April 25th, and May 10th.

*Nitrogen.*

| | 21/3/05. | 28/3/05. | 25/4/05. | 10/5/05. |
|---|---|---|---|---|
| M.grms. of nitrogen added per 100 grms. of soil .. | 10·93 | — | — | — |
| As ammonia .. .. .. .. | 1·442 | 3·940 | 4·03 | 3·295 |
| As nitrites and nitrates .. | 0·088 | 0·036 | 1·367 | 1·646 |
| As ammonia, and nitrites and nitrates .. .. .. .. | 1·530 | 3·904 | 5·387 | 4·941 |
| As ammonia in check .. .. | 0·249 | 0·394 | 0·299 | 0·133 |
| As ammonia, nitrites and nitrates in check .. .. | 1·231 | 1·045 | 1·950 | 1·650 |
| Percentage of added nitrogen converted into ammonia, nitrites and nitrates.. .. | — | 23·4 | 28·8 | 27·4 |

*Experiment* III.—In this series the potassium salt was used, the amount being equivalent to an application of 361 lbs. per acre of a compound containing 16 per cent nitrogen. The soil used, as in Experiment II., constituted a portion of that employed in Experiment I. The experiment was started March 21st, 1905, and subsequent determinations of the nitrogen compounds were made on March 28th, April 25th, and May 10th.

*Nitrogen.*

| | 21/3/05. | 28/3/05. | 25/4/05. | 10/5/05. |
|---|---|---|---|---|
| M.grms. of nitrogen added per 100 grms. of soil .. | 5·78 | — | — | — |
| As ammonia .. .. .. .. | 1·442 | 2·737 | 2·838 | 1·871 |
| As nitrites and nitrates .. | 0·088 | 0·058 | 0·416 | 1·281 |
| As ammonia, and nitrites and nitrates .. .. .. | 1·530 | 2·795 | 3·254 | 3·162 |
| As ammonia in check .. .. | 0·249 | 3·94 | 2·99 | 0·133 |
| As ammonia, nitrites and nitrates in check .. .. | 1·231 | 1·045 | 1·950 | 1·650 |
| Percentage of added nitrogen converted into ammonia, nitrites and nitrates.. .. | — | 25·1 | 17·4 | 20·0 |

The decrease in the percentage of nitrogen converted into available forms, as recorded in the last two tables, is apparent rather than real. It arises from the fact that there was a large and apparently unexplainable falling off in the available nitrogen in the check pots, the differences in which from time to time were necessarily used in the calculations to arrive at the conversion of the nitrogen of the cyanamide compound apart from that of the soil proper.

It would seem from a consideration of the data of this research that with the increase in the amount of the cyanamide compound there is a concomitant decrease in the rate of nitrification. This is probably due, as already indicated, to a toxic action upon the nitrifying organisms by the cyanamide compound, which action would naturally be increased the larger the application. On the other hand, it may in part be due to denitrifying changes leading to the loss of nitrogen in the free state.

The conversion of the nitrogen of the cyanamide into available forms is most probably, under favourable conditions, continuous, though not uniformly so. The first stage may be considered possibly as purely chemical, since water at ordinary temperatures converts the nitrogen of cyanamide into ammonia. The further changes being brought about through the agency of living organisms are necessarily slower, and will be regulated by many factors, prominent among which, as we have observed, is the proportion of the cyanamide compound present in the soil.

## SULPHUR IN ITS RELATIONS TO OTHER ELEMENTS.

By JOHN CLARK THOMLINSON, B.Sc. (Dunelm).

In carbon dioxide and disulphide we have two compounds to which, from their analogous relations to such compounds as urea, thiourea, &c., we assign a constitutional formula identical in each case.

The thermal behaviour of carbon, as shown in a previous article (Chemical News, vol. xciii., p. 37), warrants us in assigning to it the formula $C\overset{O}{\underset{O}{\equiv}}$, rather than $C\begin{matrix}O\\|\\O\end{matrix}$; therefore we are justified in regarding that of carbon disulphide as $C\overset{S}{\underset{S}{\equiv}}$.

There exists an intermediate compound—carbonyl sulphide, COS—to those already mentioned, which, for the same reasons, we consider has a constitution represented by the formula $C\overset{O}{\underset{S}{\equiv}}$.

The following thermal equations represent the heats of formation of the above compounds, and of carbon monoxide, CO.

| | | | |
|---|---|---|---|
| $C+O+S$ | = | 37·030 calories . . . . | I. |
| $C+S_2$ | = | −26·010 „ . . . . | II. |
| $C+O_2$ | = | 96·960 „ . . . . | III. |
| $C+O$ | = | 29·000 „ . . . . | IV. |

If we endeavour to determine the thermal value of sulphur in carbonyl sulphide as formed respectively from $CO_2$ and CO by the substitution and addition of an atom of sulphur, we can show that the results, as determined from two sets of data, are of the same magnitude; and that, applying the mean of these two results—for we are not justified in accepting either as being nearer the truth—to the heat of formation of carbon disulphide, we get an extremely close approximation between calculation and experiment, the difference being perhaps not greater than experimental error.

In the first case, we will suppose one carbon atom uniting with one oxygen atom and one sulphur atom as behaving thermally exactly as in the case of carbon dioxide, and that an oxygen atom is thermally equivalent in carbonyl sulphide and dioxide; then, from the thermal equivalents we have already shown are probable for carbon and oxygen (*vide* former article), C = −8·130 calories and O = 52·545 calories. Then the two atoms in uniting would cause a heat evolution = 44·415 calories, and as the heat of formation of carbonyl sulphide, COS, equals 37·030 calories, the difference between these two numbers will give the thermal value of the sulphur atom as −7·385 cals.

In the reaction in which carbonyl sulphide is formed from carbon monoxide and sulphur we have the thermal equation—

$$C=O+S=C\overset{O}{\underset{S}{\equiv}} + 8{\cdot}030 \text{ calories} \quad . \quad . \quad . \quad . \quad \text{V.}$$

The carbon atom, in changing from the di- to quadrivalent form, causes an evolution of heat = 19,480 calories (Equations III. and IV.), and the difference between this number and that of the formation of carbonyl sulphide from carbon monoxide and sulphur (Equation V.) is 19,480 − 8·030 = 11·450 calories, which, with the negative sign, or −11·450, represents the absorption of heat due to the union of the atom of sulphur.

The mean of these two numbers, −7·385 calories and −11·450 calories, for the heat of combination of sulphur is −9·418 calories; and applying this value to our original formula for carbon disulphide, which we regard as having the constitutional formula $C\overset{S}{\underset{S}{\equiv}}$, we find the heat of formation of this compound to be, by calculation, −26·966 calories, and that determined by experiment is −26·010 calories.

In sulphur dioxide, $SO_2$, sulphur is more probably quadrivalent, $S\overset{O}{\underset{O}{\equiv}}$, than divalent, $S\begin{matrix}O\\|\\O\end{matrix}$, the former being the more stable form of combination; if $S\begin{matrix}O\\|\\O\end{matrix}$ were correct, we should expect—from analogy with hydrogen peroxide ($H_2O_2$) and water ($H_2O$)—ozone ($O_3$) and oxygen ($O_2$) to have a compound of the formula SO, and such has not been prepared.

The heat of formation of sulphur dioxide is 77·280 calories, and, from the thermal value of the oxygen atom (O = 52·545), we find the heat of combination of quadrivalent sulphur to be −105·090 + 77·280 = −27·810 cals.

For reasons similar to those in the case of sulphur dioxide, we should regard sulphur as hexavalent in sulphur trioxide, and, if so, the value −27·810 calories for quadrivalent sulphur should be the mean of that of hexavalent and divalent sulphur, and as quadrivalent sulphur has a thermal value −18·392 cals. greater than when divalent, the heat of combination of hexavalent sulphur should be −27·810 − 18·392 = −46·202 cals., which gives the heat

of formation of sulphur trioxide ($SO_3$) as 111·433 cals., and the value found by experiment is 103·320 cals. For sulphuric acid, which we regard as having the formula $\begin{matrix} H-O \\ H-O \end{matrix}\!\!>S\!\!\begin{matrix} =O \\ =O \end{matrix}$, calculation gives a heat of formation 178·918 cals., and experiment 192·920 cals.; and for the acid of the formula $H_2S_2O_7$ the values are respectively 290·351 and 230·500 cals.

The above attempt at showing what is probably the thermal value of sulphur in some of its compounds helps us to see a distinct dynamical signification in the idea of valency.

## RADIUM.

### LETTERS FROM "THE TIMES."*

(Continued from p. 145).

(August 28, 1906).

SIR,—Your leading article (August 18) and recent correspondence show that an emphatic statement is needed to make clear to your lay readers:—

1. That radium is not an ordinary chemical compound.
2. That it does disintegrate with explosive violence.
3. That it is present in sufficient quantity to account for the heat of the earth.
4. That its disintegration is not altered by any known physical conditions.

Some experimental results obtained by me last spring at Montreal, under the guidance of Prof. Rutherford, are in good agreement with those found independently and by a different method by the Hon. R. J. Strutt. The equivalent amount of radium present in the upper layers of the earth was determined by the penetrating radiation resulting from the active matter. An account of this work has been communicated to the *Philosophical Magazine* and is in the printer's hands.

It is certain that radium does occur in sufficient quantity, and that its heat energy is of sufficient magnitude, to account for the existing temperature-gradients of the earth. Until we can conduct experiments in the interior of the earth, the radium theory is entitled to at least as much weight as the gravitation theory.

The recent discussion in your columns has resulted in a goodly crop of errors, written by those who have contented themselves with reading rather than with research work. I believe that no actual worker at the subject dissents from the general conclusions contained in Rutherford's "Radio-activity."

For example, it has been implied that radium is merely an ordinary compound of lead (?) and helium. But no ordinary chemical compound projects a particle, having the mass of a helium atom, with a velocity almost of the order of the velocity of light.

It has been stated that the disintegration of radium occurs too slowly to be detected by direct observation, and that is true. But some of the other active bodies, such as the subsequent products of radium, disintegrate with no less violence in a few minutes. It has been suggested that the disintegration may be retarded by pressure or by lack of concentration; but all the evidence—and there is much—indicates that the process of disintegration can neither be accelerated nor retarded by temperature, pressure, concentration, or other physical changes.

It is to be hoped that reverence for a great name and an honoured veteran will not induce your readers to regard lightly the brilliant and remarkable series of recent scientific discoveries in radio-activity.—Yours faithfully,

A. S. EVE.

Hull, Aug. 25.

* These Letters from *The Times* have reference to the Discussion on "Radio-activity and the Internal Structure of the Earth," at the York Meeting of the British Association (Section A), August 6, 1906.

(August 31, 1906).

SIR,—The correspondence started by Lord Kelvin in your columns would be incomplete if some one did not draw attention to the points of agreement as well as the points of difference between the distinguished scientific leader and the active workers in the field of radio-activity.

Lord Kelvin accepts as a fact, and, as he himself says, has never contested, the production of helium from radium. For this reason your leading article of the 18th inst., in so far as it tended to throw doubt on the validity of this fact, is misleading. If it is true that the spectroscopic examination of gaseous mixtures requires practical training and experience, it is equally true, for the same reason, that anonymous criticism of results obtained by those methods is intolerable. No spectroscopist of standing has openly questioned the result. Some who doubted the results as initially put forward by Sir W. Ramsay and myself have been convinced in the best possible way, by trying the experiment for themselves. Although their results, as so far published, have been uniformly confirmatory, it is perhaps not out of place to remark that none of them have proved as much as the original experiments—namely, that the radium emanation produces helium. The confirmatory labours of the foreign investigators have been mainly directed towards excluding the possibility of helium being occluded by the radium salt, whereas our experiments showed that a gas that had been condensed by liquid air, and so freed from free helium, developed the helium spectrum after some days. It is, in my opinion, a mistake to suppose that these experiments of themselves offered any conclusive evidence of the character of the change, whether chemical or transmutational, by which the helium was produced from the radium emanation.

Lord Kelvin argues that because helium is being continually produced from radium it is wrong to conclude that all the helium has been removed in the first place. Helium is, however, not the only new substance which a solution of radium continuously generates. I am speaking of facts that must be familiar to every one who has kept under observation a solution of radium in an air-tight vessel. The radium emanation is continually produced by the radium solution. The term "radium emanation" may be unfortunate, but it is used by workers in radio-activity to mean one definite product of radium of peculiarly definite material nature. It is a gas; it is condensed sharply at a certain temperature to the non-gaseous state; it has intense radio-activity of a characteristic kind; it generates in time a non-volatile radio-active product of new and equally characteristic properties; and last, but not least, it has been shown by experimental measurements to generate spontaneously in every second of time as much heat as the same volume of a mixture of hydrogen and oxygen when exploded to form water.

Now, if all the radium emanation is pumped off from a solution of radium, it is found after an interval that a further supply can again be extracted. Does Lord Kelvin argue that the "if" is wrong in this case also? The removal of the intensely radio-active emanation causes the $\beta$-radiation of the radium to become zero, and the $\alpha$-radiation and the heat evolved both to fall to 25 per cent of the initial value, while the emanation and its non-volatile products emit the whole of the radiation and the heat which the radium has lost the power of emitting. With lapse of time the radium, kept in a closed vessel, regains its original activity, and then a new amount of emanation may again be pumped off and the activity of the radium again reduced as before. These processes have been carried out with a sample of radium in my possession for many years, yet it gives appreciably no less emanation now than formerly. If all the emanation that has been produced and extracted during these years was present in the original radium, why was it not at first incomparably more radio-active than it is now? We think therefore that there is ample justification for the conclusion that when no more emanation can be extracted from a radium solution it is for the reason that no more exists therein,

and that a real reproduction of the emanation with lapse of time is taking place. If this is true for the emanation it must be true also for the helium which is formed from the emanation, so Lord Kelvin's argument can be definitely answered.

It was upon evidence of this character, exhibited with wonderful uniformity by all radio-active matter, that the disintegration hypothesis was put forward by Prof. Rutherford and myself, long before helium had been thought of in this connection, and even before the magnetic deviability of the α-ray had been established. I must protest against the helium discovery being considered "isolated" or as being anything more than confirmatory.

I suppose that no one would wish to advocate the view that radium creates helium, the emanation, &c., which are known to be produced by it. In a sense, therefore, the products all pre-exist in the original radium, and the real question is as to the exact character of the decomposition by which they are formed. If chemists are antagonistic to the idea of atomic disintegration, they should be equally antagonistic to the idea, expressed in Lord Kelvin's letter of the 24th inst., of the formation of radium by the concourse of atoms of helium and (?) lead, for radium has passed its chemical and spectroscopic examination for elementary character as well as the oldest elements known.

During a recent visit I had many long conversations with Lord Kelvin in which he honoured me with his views and criticisms on these topics. I found far less divergence of opinion between his views and those of active workers in the subject than I had imagined previously. The main differences seemed to centre round the propriety of using the terms atom and element in connection with substances which had been shown by experiment to undergo change. I do not wish to imply that the differences are merely of nomenclature. On the contrary, they affect the whole question which was discussed at York—at once the most important, the most interesting, and the most speculative in radio-activity at the present time—of how far conclusions drawn from the study of radio-active matter may be applied to ordinary inactive matter.

Of course my personal impression of Lord Kelvin's views may be quite mistaken, but I think I am safe in saying that he would not wish to be among those who seem in their antagonism to the "radium theory" to overlook the existence of radium as a fact. Lord Kelvin in his letters has indicated that he accepts the evidence that radium is continually generating helium and other bodies. This being so, I do not think that the remaining differences, although admittedly important, should divide him irreconcilably from us.

FREDERICK SODDY.

The University, Glasgow, Aug. 25.

(September 4, 1906).

SIR,—I am glad that Prof. Soddy has to-day summed up the amount of residual opposition in the radium controversy in a clear and forcible and yet conciliatory manner. Your columns did not seem to me a suitable medium for continuing a discussion which, judging from your leading article, struck outsiders as savouring of discourtesy to a veteran; but it is an eminently suitable vehicle for indicating a measured amount of agreement.

The key of the position is the elementary or the compound character of radium. Nearly all physicists, following Rutherford and Soddy in the first instance, now consider it to be a disintegrating element displaying a novel form of energy; Lord Kelvin and a few chemists enlisting under his banner pronounce it an explosively decomposing compound. All agree that it must be being "born" somehow, because of its comparatively short life; but whereas the experimenters assert that they know its parentage, Lord Kelvin thinks them too definite in that respect. There remains an outstanding difference with the Hon. R. J. Strutt about the source of the present heat in the crust of the earth; and that is about all.

The controversy about the elementary or the compound nature of the radium atom is not one that need be settled offhand. It does not really depend on the use of terms; there will be no need for chemists to alter the use of the convenient names "element" and "atom" because their etymology has become archaic, even when the physicists have turned out completely right. If radium splits up, as it does, it must in some sense be compound; and yet in every respect it behaves as much like an element, of the calcium-strontium-barium series, as any other element whose spectrum, atomic weight, and family relationship are known. Moreover, I believe that its instability, compared with that of other elements, is only a question of degree, not of kind; for radio-activity has been provisionally shown in the Cavendish Laboratory to be a property of nearly all matter.

Is it to be supposed that all the elements are compound then? That would not be at all a clear or helpful way of putting the matter. Chemical decomposition is affected by heat and by pressure; atomic disintegration is not likely to be affected by these external details; and radium has been shown by several workers to be appreciably unaffected by extreme heat or cold, and Schuster has found no influence of pressure up to thousands of atmospheres. In my judgment the burden of proof now rests with those who take the comparatively uninteresting view of the isolated nature of radium as a mere eccentric chemical compound.

Physicists generally are likely to feel, as I do, that, while expressing the greatest respect for the leader who as yet differs from them in some particulars, we must be fair to the workers in many parts of the world, to whom we owe this great extension of knowledge, confirmatory of the instability of the atom of matter already suspected by great mathematicians in accordance with high electrical and radiation theory.—I am, Sir, faithfully yours,

OLIVER LODGE.

The University, Birmingham, Aug. 31.

(To be continued).

## ORE DEPOSITS AND THEIR DISTRIBUTION IN DEPTH.*

By Prof. JOHN W. GREGORY, D.Sc., F.R.S.

(Concluded from p. 143).

### *Surface Enrichment—Primary and Secondary.*

THIS primary richness of the outcrop is reinforced by a secondary enrichment, to which the richest bonanzas and prizes of the mining industry are due. The secondary enrichment is, from a mining point of view, and especially in the valuation of a mining field, the more important process. Its nature may be illustrated by reference to a gold quartz vein, formed by an ascending solution, which had deposited gold uniformly in a vertical lode; if the ground containing the lode is slowly lowered by denudation, the gold in the uppermost part of the lode is dissolved by a solution formed by the action of surface waters on the iron pyrites in the lode. The gold is carried a stage lower, where the ferrous sulphate is reduced, and gold and pyrites re-deposited. So the cap of the lode now has concentrated within it the metals originally distributed through twice the length. The process is repeated again and again until a rich gold patch, such as the famous Londonderry pocket, may cap an otherwise worthless lode.

It is as an index of the extent to which ores have been thus secondarily enriched that the mineralogical study of lodes is of high economic importance.

All ore formation is essentially a process of concentration; the specific gravity of ordinary ores may be taken as 3·4; the rocks of the lithosphere have a specific gravity of 2·5; the barysphere must contain masses of a specific

* A Discourse delivered at the Royal Institution, April 27, 1906.

gravity of at least 6 and 7, and the average specific gravity of the average zone at the depth of 37,000 feet will be only 2·52. But as ore formation probably takes place where the barysphere is nearer the surface, its specific gravity at the critical temperature of water beneath a mining field in process of formation will probably be higher. But it can hardly be more than 3·0. So the metals in this zone of the crust will be more diffused than in a lode. The process of ore formation is the collection of the scattered particles, their concentration in a lode, and then the sorting out of the mixed, complex, primary constituents into purer, simpler, secondary minerals.

Thus, gold in a deep lode is always alloyed with silver, and probably with lead, zinc, and antimony as well. It is only near the surface that gold occurs with only 3 parts in the 1000 of silver; there are veins of native metals.

Similarily with silver; its deep ores are always alloyed with lead. It occurs as native silver and as horn-silver only in shallow ores.

Again, with copper, the primary ores are complex sulphides combined with iron. Thus the commonest primary ore is of copper chalcopyrite with 34·5 per cent of copper and 30·5 per cent of iron; and the mineral occurs as streaks in iron pyrites, so that the copper is often only 1 or 2 per cent of the ore. This material is attacked, its constituents dissolved and re-deposited, probably as veins of bornite, which contains 55·5 per cent of copper and only 16·4 per cent of iron; and bornite often occurs in comparatively pure veins, the great bulk of the iron having been deposited apart as veins of hæmatite. The secondary bornite is then in turn attacked, and the copper re-deposited as the tertiary minerals, covellite, with 66·4 per cent of copper, or cuprite, with 88·8 per cent and no iron; and in the last stage in the process the copper occurs in veins or masses of native copper.

The depths to which ores will descend depend on the factors that control both their deposition and concentration. In considering the future of any mining field, the question of primary importance is whether the ores have been deposited by ascending or descending solutions, and we are beginning to acquire sufficient knowledge to form some idea as to the probable depths to which various types of ore-deposits will go.

Thus, there is no reason why gold quartz lodes should not go down to depths of about 18,000 feet below the level of the surface at the time of their formation. Hence, in estimating the depth to which any particular lode will go, we have to consider how much of the upper part of the lode may have been destroyed by denudation. In two adjacent mining fields, in one the lodes may continue to be auriferous to the depth of 5000 or 7000 feet from the present surface, whereas, in the other, where the lodes were formed in precisely the same way, the ore shoots may be quite shallow. The disappointing result in the second case is due to the upper part of the lodes having been removed by denudation, so that only the barren roots remain.

To plunge into deep mining regardless of the geological structure and history of the field is to invite failure. And deep mining to be profitable must be so organised as to work low grade ores economically, and to reduce dead work to a minimum by a plan of mining adapted to the geological structure of the field.

Gold mines worked thus at Bendigo have already reached the depth of 4250 feet, and the success there is the more remarkable as the mines are not working continuous lodes, but isolated masses of quartz. The reefs are saddle-shaped folds of quartz, floating in folded beds of slate and quartzite. It was not until the clue to the distribution of these isolated quartz masses was discovered that there was any chance of working the mines deeply, And though the field shows the usual decrease in grade, there is no indication that the loweet reefs have been approached.

In some fields the mines will be doubtless more shallow. Thus ores in lavas and horizontal stratified rocks, whether formed as contact deposits near igneous intrusions, or along fault planes and fractures, up to which hot solutions have ascended, are likely to be patchy, owing to the sensitiveness with which such liquids respond to slight variations in the conditions. The depths of the ores will be directly determined by the thickness of the stratified rocks, and this is usually a simple problem of field geology. There is less probability of the ores continuing to as great a depth, as in infolded uptilted masses of ancient rocks.

The vast masses of pyritic ores represent a third type, which is of a special historic interest. They were at one time regarded, as they still are by some geologists, as bedded ores, precipitated in ancient lakes, by the action of decomposing organic matter, on materials introduced by streams. The ores were expected to continue to vast depths, because they are often hundreds of feet in width, and the horizontal extent of a sedimentary deposit is usually dozens, and may be hundreds, of times greater than its vertical thickness. So the depths of the ore-body was expected to be many times its thickness, and as one lenticular ore-deposit thinned out, others were expected to come in at slightly different levels. But these pyritic ore-masses have been found to be comparatively shallow in depth; none has yet been worked to the depth of 1000 feet, and for their shallowness there are excellent reasons; they are secondary deposits, formed by ore-bearing solutions replacing, particle by particle, shattered masses of rocks. The replacement has been so slow that the aspect of the original bedding is often still preserved, leading to the view that the pyrites itself was a bedded deposit. The shattered rock masses necessary for the formation of these huge ore-bodies can only occur near the surface; for at greater depths the weight of the overlying rocks would make the softer finer material flow into the interspaces between the harder fragments; the very force that fractured the rocks would also compress them, so as to render the crushed mass impermeable. Solutions might work their way along fractures, depositing ordinary fissure-veins, and replacement-veins on their edges; but there will be nothing like the widespread permeation which has produced the great pyritic ore-bodies. It is only natural that in these cases the mines should not reach the same depths as ores deposited along the channels of solutions escaping from plutonic depths.

### *Shallow and Deep Ore Types.*

The distribution of ores in depth may therefore be usually inferred from a combined study of the geological structure of a mining field and the mineralogical characters of its ores. A definite conclusion is not always possible, as in the absence of these data, or when dealing with new types of ore-deposits. But in ordinary cases a general opinion can be expressed.

Thus there are three groups of ore-deposits which must be expected to have comparatively shallow limits. They are:—

1. Ores that have been deposited in fissures and open spaces, which cannot remain open at great depths. Hence, such ores if continued deeper, will be continued by ores of different character.

2. Ore-masses formed by the replacement of blocks of shattered rocks, because masses of crushed rocks at great depths would be closed by the flowing of the softer materials, and thus be impermeable to all ore-bearing solutions.

3. Ores formed by precipitation from descending solutions, including nuggets, bonanzas, and the various types of secondary enrichments, and also many ironstone masses and beds.

On the other hand, there are three types of ore-deposit which may persist to great depths. They are:—

1. Lodes characterised mineralogically by low-grade alloys, and complex sulphides with small percentages of the more valuable metals, and geologically by their occurrence as replacement veins along great fault planes, or as isolated bodies along lines of special permeability in folded rocks.

The limit in depth of such ores is the level of maximum saturation, which must occur, as a rule, at the depth of about 18,000 feet, for at that depth the ascending plutonic waters must begin to deposit their metallic salts.

2. A second group of ores with a possible great extension in depth are those of sedimentary origin, in tilted rock masses; for they can extend as deeply as such rocks can be buried without being metamorphosed by the earth's internal heat.

3. The third group of possibly deep seated ores are those formed by the segregation of metallic minerals from molten rock magmas.

These three groups of ores hold reserves of ore, the deep working of which is controlled by the elastic limits of expense. The assumed boundary of practical mining is being continually pushed downward. Once the final limit was accepted as 3000 feet, but there are already gold mines working at the depth of 4250 feet, and copper mines at 5000 feet, and preparations are being made for mining at 6000 feet. The greatest obstacle to deep mining is the high temperature; but that can be reduced by ventilation with compressed air or by the circulation of cold brine. It is unnecessary to suggest the powers given to the miner by liquid air. It gives him means of cooling and ventilation to which it is difficult to set a limit. There can be no doubt that the ore-deposits below the present limits of mining, for the existence of which the geologist can safely vouch, will one day be accessible. The profitable working of these deeper ores will require the close co-operation of the engineer and the geologist. Then the miner, armed with the invincible ingenuity of the engineer, and guided by the insight of the geologist, will follow the ore-shoots, in their irregular courses, into ever deeper layers of the earth's crust, and wrest from them their long hidden secrets and their well buried stores of wealth.

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NOTES ON

## AN ALLOTROPIC FORM OF ARSENIC

AND ON THE

## ESTIMATION OF ARSENIC WHEN IN MINUTE QUANTITIES.*

By WILLIAM THOMSON, F.R.S.E., F.I.C.

I WISH to call attention to a peculiar allotropic form of arsenic which is produced when that substance is sublimed and rapidly condensed *in vacuo* or in presence of an inert gas, such as hydrogen or carbon dioxide. When in small quantities it condenses as a white film which rapidly becomes black. This blackening is brought about almost instantaneously by the light from a burning magnesium wire, or by bright daylight, but it takes place rather rapidly by ordinary gas-light, and the whiteness is not preserved when the film is kept in the dark. It continues white for a longer time when kept at the ordinary temperature of the atmosphere than when heated to, say, 100° C. It becomes black in about twenty minutes when cold and in the dark, and in about five minutes in diffused light.

A platinum-wire covered with a thin layer of glass upon which ordinary arsenic was laid was enclosed in a glass bulb. A vacuum was made in the bulb by a Töpler vacuum pump till no more air could be extracted, and left twenty-four hours over phosphoric anhydride. The pump was again worked, and proved that no leakage of air into the bulb had taken place. A current of electricity was then passed through the wire to heat it to redness, and so evaporate some of the arsenic, which condensed on the top of the bulb as a white film, and rapidly became black, as it did when sublimed in an atmosphere of hydrogen or of carbonic anhydride.

It occurred to me that this blackening action in the dark may be due to some obscure radiations which are everywhere present, and some experiments were made by enclosing these films in thick lead tubes, but they appeared to blacken when so enclosed just as rapidly as when enclosed in an ordinary wooden pencil case. Nevertheless, these white films may prove of interest to the physicist, as some means may be found for preserving their whiteness, and so making it possible to determine the presence of certain radiations as yet unknown.

On placing tubes containing these mirrors in liquid air they remained white for five hours, during which time they were immersed. The test mirror which was momentarily withdrawn from the liquid air from time to time became blackened, whilst the others which were immersed and in the dark, remained white.

I find that this form of arsenic has been studied by several observers (see Note), but more especially by Hugo Erdmann and Max von Unruh, who find that it is more volatile than the black form (which our observations confirm). They say—it is soluble in carbon disulphide, and whilst in solution it is not affected by light, but may be recovered as a yellow deposit on evaporation of the solvent, and it is then very sensitive to all kinds of light. On being left in solution in a stoppered bottle a reddish form of arsenic is produced which gradually falls from solution.

NOTE.—Schuller, *Math. u. Naturn. Ber. aus Ungarn.*, 1889, vol. vi., p. 94. Reigers, *Zeit. Anorg. Chem.*, vol. iv., pp. 403—409; vol. vi., pp. 397—320. McLeod, CHEMICAL NEWS, 1894, vol. lxx., p. 139. Linck, *Zeit. Kryst. Min.*, 1896, vol. xxvi., p. 280. Erdmann and Max von Unruh, *Zeit. Anorg. Chem.*, 1902, vol. xxxii., pp. 437—452.

### *Improvement in the Cooling Method for Condensing the Arsenic Mirrors in Arsenic Determinations.*

The results obtained by the method which I formerly adopted of running a stream of cold water over a piece of tissue paper covering the drawn out portion of the tube, leave something to be desired, especially in the estimation of exceedingly minute quantities of arsenic, for the water at the edge of the paper next the flame does not give an exceedingly sharp line of cooling surface, and we have improved on this by taking a piece of block tin tube 8 inches long, having an internal bore of $\frac{3}{16}$th inch. This tube is flattened so that the internal measurements become $\frac{1}{4}$ inch × $\frac{1}{8}$ inch, and it is bent downwards in a curve about $\frac{3}{4}$ inch from the end. Two holes are made in the edges of the flattened tube opposite each other 2 inches from the bent end, and a thin silver-foil plate soldered over one of these holes. This plate is perforated by drilling in it a hole of a diameter sufficient to allow the drawn out portion of the largest sized glass tube to fit it. The tube is passed through the silver plate to the point at which the mirror is to be formed, and the water turned on through the tin tube, which is connected with the main by a thin rubber tube. A gentle flow of water is kept running through this tube, and it is found that if the length of the bent end of the tin tube is properly adjusted the water does not escape at the silver plate or the hole in the tin tube opposite, even when the tubes fit comparatively loosely. By this device 1/2000th of a grain per gallon of arsenic trioxide when working on 50 c.c. of the solution can be readily seen as a distinct narrow metallic ring, and the larger mirrors are more evenly deposited.

### *Influence of Nitrous Compounds on the Estimation of Minute Quantities of Arsenic.*

I observed in making tests by the electrolytic as compared with the Marsh-Berzelius method that in some cases considerably larger mirrors were obtained by the latter than by the former, and on investigation it turned out that this difference was due to the fact that all the nitrous compounds used for the destruction of the organic matter had not been removed. To be certain of the results by the electrolytic

* A Paper read before the Manchester Literary and Philosophical Society, March 13, 1906. From *Memoirs and Proceedings of the Manchester Literary and Philosophical Society*, vol. l., Part III.

process it becomes necessary that the sulphuric acid should be evaporated to its fuming point, diluted with twice its volume of water, and again evaporated to the fuming point, and this should be again repeated to ensure the elimination of all of the nitrous compounds, so that the proper size and depth of arsenic mirrors may be obtained by the electrolytic process in the time allowed for the test. With the Marsh-Berzelius method the presence of some nitrous compounds does not so materially affect the result.

With a view of studying the influence of nitric acid in the electrolytic apparatus, a dilute solution equivalent to half a c.c. of the ordinary strong acid of commerce (0·48 grm. $HNO_3$) was added separately to an electrolytic apparatus—the first with a lead, the second with a zinc, and the third with a graphite cathode. This acid was gradually converted into ammonia in each apparatus, the amount of which was then determined. A current of 3 ampères was employed, and each apparatus was worked in series. After forty-five minutes the ammonia in the solutions in the various cathode chambers was determined, and the following results obtained :—

| | $HNO_3$ reduced to $NH_3$ in 45 minutes. |
|---|---|
| Lead cathode (*a*) .. .. .. .. .. | 0·22 grm. |
| Zinc cathode.. .. .. .. .. .. | 0·21 ,, |
| Graphite cathode.. .. .. .. .. | 0·10 ,, |

(*a*) This lead cathode was made and kindly given to me by Mr. J. E. Hackford, of Nottingham. The lead used having been purified from traces of arsenic and antimony by him by fusing with sodium, and afterwards stirring up with pure fused sodium chloride while the lead is still at a high temperature.

This shows that the rate of decomposition was about the same with lead and zinc cathodes, whilst the graphite cathode only exerted about one-half the reducing action.

(To be continued).

## NOTICES OF BOOKS.

*The Electrical Nature of Matter and Radio-activity.* By HARRY C. JONES. London: Archibald Constable and Co., Ltd. 1906.

THE contents of this book were originally published in the form of a series of articles, which appeared in the *Electrical Review*, and which have been revised and consolidated into a single volume. The object of the book is to explain something of the theory of radio-activity from a non-mathematical point of view, and to expound the subject in such a way that it will be easily understood by the general reader, and will at the same time give him correct scientific views. While the treatment in many respects leaves little to be desired it is hardly interesting enough for a popular work, and extra attention paid to practical considerations would add to its attractiveness. Exception must be made in favour of an excellent chapter on theory, in which the facts which have been discovered are well discussed, and generalisations based upon them are skilfully deduced. Although the book makes no pretension to be regarded as a text-book providing a rigidly mathematical treatment of the subject, it will perhaps serve as an introduction to the study of a more advanced work.

*Elementary Chemistry. Progressive Lessons in Experiment and Theory.* Part II. By F. R. L. WILSON, M.A., and G. W. HEDLEY, M.A. Oxford: Clarendon Press. 1906.

THE second part of this course of experimental chemistry introduces subjects of a more strictly chemical nature than were contained in the first part, and the author's plan appears more satisfactory than when applied to the introductory physics and mensuration which were dealt with in the preceding volume. The preliminary sets of questions which begin each chapter, and which the pupil is expected to answer from his general knowledge, ought undoubtedly to make him think, and give him some practice in reducing his thoughts to writing, which presents such difficulties to the average boy; while the teacher will be relieved of much supervision and explanation relating to details of manipulation, which are fully described in the directions for the experiments, the diagrammatic illustrations being very useful for the purpose. The attention paid to the historical aspects of elementary chemistry will awaken the pupil's interest, and help him to regard the science as one which is still living and growing, while the chapters on theory are also suggestive. Experience shows that a little theory is eagerly assimilated by those who have got to a certain stage of experimental knowledge, and the authors appear to have guaged very well the amount which is sufficient to awaken interest without making too great demands upon reasoning powers or faith; the simple electrical work introduced should also be valuable, and the course can be recommended for the use of pupils of about fourteen or fifteen years of age.

*Forty-second Annual Report on Alkali, &c., Works.* By the CHIEF INSPECTOR. London: Eyre and Spottiswoode. 1906.

THE Chief Inspector's forty-second annual report on alkali and other works has to chronicle a revival of manufacturing activity in many directions during the year 1905, and a correspondingly larger numbers of visits of inspection and of tests. A *résumé* of the account of the investigations of the United Alkali Company with regard to the reactions in the Claus kiln is given, and recent important researches on subjects connected with the manufacture of sulphuric acid are also abstracted and discussed. A research on the analysis of ammoniacal gas liquors, with special reference to the distribution of the cyanogen compounds in them, and the conditions under which ammonium cyanide is a notable product, is communicated at length, and is of great interest for those engaged in processes for cyanide recovery, and a similar report on the conditions affecting the formation of ferrocyanides in sulphate of ammonia saturators is also included.

## CORRESPONDENCE.

### NEW CLASSIFICATION OF THE ELEMENTS.

*To the Editor of the Chemical News.*

SIR,—I have attempted a new classification of the so-called elements, a few series of which I give below. Instead of the usual method of adopting the atomic weight as the index to the behaviour of an element, I have taken the specific gravity as my guide. I have done so because the latter varies with the allotropic forms of the substance, whilst the former is looked upon as a constant. The specific gravity is therefore, in my opinion, a preferable index to the internal molecular state. P and S, among others, have a varying valency and also a varying specific gravity. Such variations give various affinities, which the atomic weight cannot indicate alone.

| | |
|---|---|
| Os, 22·47 | Ru, 12·26 |
| Ir, 22·38 | Rh, 12·1; Tl, 11·8 |
| Pt, 21·5 | Pd, Pb, Th, 11—11·4 |
| Au, 19·3 | Ag, 10·5 |
| U, W, 18—19 | Ta, 10·4; Bi, 9·8; Mo, 9 |
| Hg, 14 | Cu, Cd, 8·7 |
| Ni, Co, Mn, 8—8·7 | La, Cr, Va, 6 |
| Fe, 7·9; In, 7·4 | Ga, 5·96; As, 5·7 |
| Sn, 7·3; Zn, 7·1 | Ge, 5·5 |
| Nb, Ce, 7 | I, 4·9 |
| Sb, 6·7 | As, 4·7 |
| Cr, Te, 6·26 | Se, 4·3 |

The following compounds show the relationship which exists between elements classed differently by Mendeleeff:—$K_2XO_4$, in which X may be either Ru, Os, Mn, Cr, Se, or S; $XCl_2$, in which X may be either Hg, Cu, Cd, Te, or Se; $(XCl)_2$, in which X may be either Hg, Cu, or Se; $K_2XCl_4$, in which X may be either Pt, Sn, or Zn..

The numerical relationships exhibited by elements grouped together are interesting, *e.g.*,—

The ratio of the at. wt. of Pt to that of Zn is as 3 is to 1.
" " Os " Te " 3 " 2.
" " Cu " Te " 1 " 2.

The atomic volume of Cu is one-half that of Hg; those of Zn, Pt are nearly equal, whilst that of Pb is just double.

The case of the atomic weight of Te is interesting, from the fact that it will not square with the Periodic Law of Mendeleeff. The same thing occurs with argon, which has the same numerical relationship with neon as Te has with Cu.

A relationship is observable in the fusing-points of some of the elements I have grouped together, *e.g.*, that of S 387° absolute, Se 490° abs., and of Cd 593° abs. differ by a corresponding amount.

A similar arrangement of the oxides, the densities of which I obtained from Mendeleeff's admirable book, shows that compounds of an analogous composition fall into groups, just as the elements do. Does not this point to the "elements" being formed from still simpler bodies?—I am, &c.,

E. Bradbury.

Bradbury's School,
16, John Dalton Street, Manchester, Sept. 10, 1906.

## ALLEGED DISCOVERIES OF NEW METALS IN THE LAST CENTURY.

*To the Editor of the Chemical News.*

Sir,—On looking over some old newspapers in my collection, I found in one of them, *The British Luminary and Weekly Intelligence* for April 24, 1819, the following:—

"Dr. Vert, Professor of Chemistry at Gratz, has discovered in the Mine of Nickel, at Schaldmig, in Styria, a metal differing from all those hitherto known. Its principal characters are—That it is not reducible except when combined with arsenic, its oxides are white, as are also the salts resulting from it. He proposes to give it the name of Vestium."

In the above extract, as will be seen subsequently, there are two mistakes—"Dr. Vert" should read "Dr. Vest," and "Schaldmig" should be "Schladming."

Not knowing of any element in the present accepted list corresponding to the above in date of discovery, I searched the scientific journals of that period for further information, with the following results, which may interest your readers. In the *Philosophical Magazine* for 1819, p. 463, occurs the following passage:—

"*Vestium.*—This metal has its name from the discoverer, Prof. von Vest, of the Johanneum in Gratz. It is found in the nickel ore of Schladming (an ore mixed with cobalt pyrites) and also in cobalt ore. In its reguline state it has the appearance of iron, and has a fine granular structure. The existence of this metal is, however, questioned by Mr. Faraday and Dr. Wollaston."

Gratz is a University town and the capital of Styria, in which Schladming is a mining centre of some importance.

Dana, in his "Mineralogy," gives an analysis of cobaltine from Schladming, as follows:—

| | | |
|---|---|---|
| As | 43·12 | per cent |
| S | 18·73 | " |
| Co | 29·20 | " |
| Fe | 5·30 | " |
| Ni | 3·20 | " |
| | 99·55 | " |

In the same volume of the *Philosophical Magazine* (1819), on page 68, particulars occur of the alleged discovery of another new metal, in the following words:—

"*Woodianum.*—M. Lampadius gives the above name to a new metal which he has discovered in some English ores; but the characters of the ores are not mentioned in the letter he has addressed to Dr. Muller on the subject."

A later extract from the same volume (p. 305) reads:—

"*Woodianum.*—In our number for January we announced the discovery of this new metal by M. Lampadius. The material from which he obtained it was not English as first stated, but from Topschau in Hungary. It was considered an ore of cobalt, but was found to be composed of sulphur, iron, nickel, 20 per cent of this metal. Its colour is bronze-yellow, sp. gr. 11·47, it is malleable, has a hackley fracture, it is as hard as fluor-spar, it is strongly attracted by the magnet, does not tarnish at the common temperature, but does so when heated, forming a black oxide. It yields colourless solutions, but its oxide hydrated by ammonia is deep blue. Neither alkaline arseniates, nor phosphates, nor infusion of galls produce any precipitate in its solutions. Prussiate of potash gives a pearl-grey precipitate, and a plate of zinc a metallic one from its muriate solution."

Topschau is variously spelt Dodschau and Dobsina. Curiously enough, in the year following the appearance in the *Philosophical Magazine* of the above two extracts on woodianum, the following extract appeared in the *American Journal of Science and Arts*, p. 363 of the volume for 1820:—

"*A New Metal* (*Aurum Millium*).—A letter from London to a gentleman in Baltimore announces the discovery of a new metal by Mr. Mills. The writer describes the 'Aurum Millium,' as it is called, as resembling gold in colour, very durable and malleable, and not expensive (the price being 4s. to 4s. 6d. per ounce). It is hard and sonorous, and has the valuable property of not easily tarnishing, and is nearly as heavy as jewellers' gold."

If the above paragraph stood by itself one would be inclined to think that the words "new metal" had been unscientifically and loosely used to describe a new alloy. Against this must be taken the fact that the journal was conducted by Benjamin Silliman, who was Professor of Chemistry at Yale College and correspondent for various learned societies, and it is unlikely that an editor of his standing would have permitted the words "a new metal" to be used in reference to an alloy. The similarity in the names of Mills and Muller mentioned in the above extract is, of course, apparent.

Further, the qualities attributed to the "new metal" appear to be almost exactly the same as those described as belonging to woodianum. The price quoted would be extremely low for a newly-discovered metal, but—on the supposition that the new metal is the woodianum above mentioned—this would be accounted for by the fact that it is stated to occur to the extent of 20 per cent in the nickel ore in which it was found.

It will probably be within the recollection of a large number of your readers that, in the year 1889, Professor G. Krüss (of Munich University) and F. W. Schmidt claimed to have discovered that both cobalt and nickel were composed of two separate metals (one metal being common to both), and they patented a process for the separation of nickel into the two metals. (Further particulars will be found in the Chemical News for 1889).

Dr. Fleitman, who claimed a very long experience in the nickel trade, contended that ordinary commercial nickel was composed of one metal only, and supported his argument by stating that, since Professor G. Krüss and F. W. Schmidt had announced their discovery, he himself had analysed a large number of samples of commercial nickel and had not been able to find the new metals described by Professor Krüss. There is nothing, however, that would

lead to the conclusion that he examined samples of the same material that Professor Krüss used.

We thus see that, between 1819 and 1889, at three different times, a new metal is alleged to have been discovered.

In the case of the so-called "vestium," so far as I can gather, there appears to have been no proof whatever that Professor Vest failed to uphold his claim. It is true that Faraday and Wollaston doubted the existence of the new metal, but this, of course, was only natural, but I cannot trace any analysis by them of the same ore as Professor Vest experimented with.

In the case of the alleged discovery by Professor Krüss, he probably claimed too much in asserting that ordinary commercial nickel was composed of two metals. The fact that nothing further seems to have been heard of his discovery may perhaps be accounted for on the assumption that he obtained his raw material from a smelting works, as in his patent specification he speaks of "nickel raw material obtained by concentration smelting." He may, perhaps, have experimented on samples of a parcel of ore, which, when he required further quantities for confirmation, had already been worked up in the smelting works. This might very well happen in a smelting works buying parcels of ore from different mines, and probably neither Professor Krüss nor the smelters themselves were able to identify the mine from which his original samples came.

With respect to the foregoing, it is worthy of note :—

1. That the alleged discoveries were made in two cases by competent chemists who were university professors, and whose opinion should be entitled to respect.
2. That in each case the alleged discovery of a new metal was made in a nickel and cobalt ore.
3. That these ores seem to have been found within a comparatively restricted area, viz., in Austria and Hungary, whilst nickel ores from Sudbury or New Caledonia apparently present no peculiarity.
4. That these alleged discoveries although not confirmed do not seem to have been disproved by any other observer experimenting with the same material.
5. That there is a remarkable similarity between some of the properties of Woodianum as described in 1820, and the metal which Professor Krüss claims to have discovered in 1889.

| *Woodianum.* | *Prof. Krüss' Metal* |
|---|---|
| Bronze-yellow in colour. It has a black oxide. Solutions colourless. Specific gravity, 11·47. | When present in nickel to the extent of about 2 per cent communicates to it a yellowish shade. Has a black oxide. Solutions colourless. Admixture of 2 per cent with nickel appreciably increases the sp. gr. of the latter metal. |

On the other hand, assuming that the two metals are identical, there is a serious discrepancy. Woodianum is described as being precipitated by metallic zinc ; Professor Krüss distinctly states that his metal is not so precipitated, and bases his process of separation from nickel on this fact. Assuming, however, that Woodianum and Professor Krüss' metal are the same, several solutions of this contradiction occur to one, of which the most likely to my mind are :—

1. The possibilities of the metallic precipitate obtained on the zinc being some other metal than Woodianum, overlooked as being present by the discoverer of the latter metal.
2. The possibility of Professor Krüss' metal being precipitated on the zinc only after the last trace of nickel had been removed (see his patent specification) by the zinc. Assuming insufficient time had been given for the new metal to precipitate after deposition of all the nickel, Professor Krüss may have been misled on this point. He does not appear to have tried the effect of zinc on a solution of pure salt of his new metal.

Professor Krüss tried to obtain spectroscopic evidence of a new metal, but the result was apparently unsatisfactory. Unless the material were free from all trace of nickel, cobalt, and iron, metals whose spectra are very complex, it would be a very long and tedious investigation even for a skilled observer working with good apparatus.

Looking at the above facts and observing the number of coincidences, there is, I think, ample ground for further inquiry as to whether in the nickel and cobalt ores of Hungary and Austria :—

1. There are metals at present unknown to us ; or,
2. Whether in these ores metals that are known exist in such combinations or admixture as to so modify their normal qualities as to lead skilled observers to think that other and unknown metals are present.

In the extracts given above the localities of Schladming and Topschau are specifically mentioned. If any of your readers should have business or other connections with these localities, it should not be difficult for them to obtain samples of ore from the various parts of the old dump heaps of such nickel or cobalt mines in the neighbourhood as are known to have been working in 1819.

An analysis of these might lead to the re-discovery of "Vestium" and "Woodianum."—I am, &c.,

C. T. Owen.

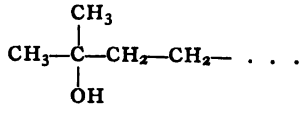
9, Fitzjohns Avenue, Hampstead, N.

## CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxliii., No. 8, August 20, 1906.

**Boiling-points of certain Secondary and Tertiary Alcohols.**—G. D. Hinrichs.—Considering the formulæ of tertiary and secondary alcohols to be—



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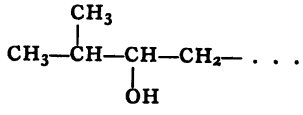

respectively, the author calculates the mass of the molecule, and hence finds the moment of inertia. He finds that for tertiary alcohols the values of the moments of inertia are smaller at the beginning of the series, but increase rapidly when the chain is prolonged, and soon exceed those of the secondary alcohols; the boiling-point is a function of the maximum moment of inertia. Thus these temperatures should increase in the same proportion, and this result has been proved both empirically and directly.

**Researches on the Relation between Functional Groups in Distant Positions. Decamethyleneimine.**—E. E. Blaise and L. Houillon.—The authors find that the relations between functional groups in the same molecule are not a periodic function of the position of these functional groups, or, at least, nothing hitherto discovered proves such a relation. This conclusion seems to be general, and to apply equally to the closing of carbon chains containing one atom of oxygen. Further, if the compounds which M. Krafft obtains are well-defined bodies, and if the properties attributed to them are exact, the base which accompanies hexylpyrrolidine is different from decamethyleneimine; this latter being non-existent.

No. 9, August 27.

**Copper Steels.**—Pierre Breuil.—The author makes a detailed investigation of copper steels containing from 0 to 10 per cent of copper with regard to (1) the breaking by shock, (2) torsion, (3) hardness, (4) corrosion. In the latter case the loss by corrosion is considerably less than that of the same steels without copper. With regard to the nature of the constituents, these steels do not differ very much from ordinary steels, except that the form, distribution, and quantity of these constituents are such that the special properties indicated in the paper are of the same interest to metallurgists as steels containing nickel or other metals which have a higher price than copper.

*Berichte der Deutschen Chemischen Gesellschaft.*
Vol. xxxix., No. 10, 1906.

**Heavy Metal Salts of very Feeble Acids.**—H. Ley and F. Werner.—By adding sodium hydroxide to a mixture of solutions of cobalt acetate and succinimide, a crystalline precipitate of cobalt succinimide, $Co(NC_4H_4O_2)_2.6H_2O$, is obtained, and the analogous nickel and copper salts can be prepared similarly. When the last named salt is hydrolysed probably the normal hydroxide, $Cu(OH)_2$, is first formed, and gives up water at the ordinary temperature, yielding a hydrated copper oxide, $3CuO.H_2O$. If camphoric acid imide is used instead of succinimide a compound containing both alkali and copper is obtained; it may be regarded as the sodium salt of a complex copper camphoric acid imide. These salts (with the exception of the nickel salt) are typical examples of exceedingly easily hydrolysed salts, which in solution in presence of excess of the free feeble acid are quite stable, but are readily hydrolysed in pure aqueous solution in the cold. The nickel salt of succinimide is much more stable than the cobalt compound, and there are indications that on hydrolysis the nickel hydroxide appears in the form of the unstable hydrosol.

**Decomposition of Hydroxylamine in presence of Hydrogen Ferrocyanide.**—K. A. Hofmann and H. Arnoldi.—If equal weights of potassium ferrocyanide and hydroxylamine chlorhydrate are boiled in aqueous solution, ammonium chloride and nitroprusside salt result, while nitrogen and hydrocyanic acid escape and a blue crystalline powder is precipitated. This precipitate is a new substance which appears to be a ferriammonium salt of hydrogen ferrocyanide, and corresponds to the formula $Fe_2C_6N_6NH_4$. According to Hofmann, there are four ferri-potassium ferrocyanides of empirical formula, $FeCy_6FeK$ + water, differing from one another, both physically and chemically, and the new ammonium compound is undoubtedly analogous to the one which has the structural formula $K(FeCy_6):Fe_2^{III}:(FeCy_6)K$. In behaviour and colour it agrees perfectly with Williamson's violet, and hence its structural formula is $NH_4(FeCy_6):Fe_2^{III}(FeCy_6)NH_4$. No change occurs even when this compound is boiled for some time with 5 per cent potassium nitrite solution, and thus the ammonium group is very firmly bound. Iron chloride solution has no action on the substance.

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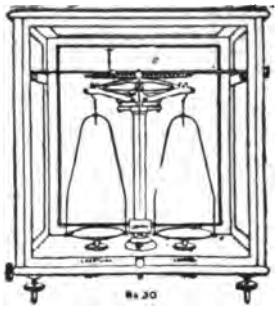

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THE CHEMICAL NEWS.

Vol. XCIV., No. 2445.

# THE APPLICATION OF PHOTOGRAPHY TO THE SOLUTION OF PROBLEMS IN CHEMISTRY.*

By WALTER NOEL HARTLEY, F.R.S.,
Royal College of Science, Dublin.

There can be no doubt that those rays in the spectrum of an element which cannot be readily recorded on a photographic plate are of little practical importance to the chemist; while, on the contrary, those which lie beyond the region of visibility are not only more numerous, but in general they constitute the most characteristic part of the spectrum of each element. An instrument which adds enormously to our powers of investigation is the spectrograph. In its simplest form it consists of a slit, two lenses, and a prism, all of quartz, in combination with a very accurately focussing camera. It records on a photographic plate the rays emitted by a substance, whether they are luminous or not, and it arranges them in the order of their refrangibilities from wave-length 4681 to 2025, with all intermediate lines sharply focussed. By the use of isochromatic plates the less refrangible rays in the red may be simultaneously photographed.

The many and various problems which the chemist is called upon to solve may be considered under two categories:—(1) Problems of composition, or analytical problems; (2) problems of molecular structure. I propose to give an account here of the applications of the spectrograph to chemical analysis, the practical applications to organic chemistry being dealt with in another section.

### *Problems connected with the Composition of the Atmosphere.*

The spark spectra of the elements are individually composed of a great number of lines presenting different characteristics, both in length, intensity, and shape, and it may be readily understood that an element can be identified by what may be termed its portraiture. Out of 2050 lines occurring in the spectra of sixteen solid elements, not four can be found to occur in any two spectra.

Some lines which appear to be common to all the different spectra belong to the gaseous elements of the atmosphere, and their total number, as originally photographed, was 195. They were proved (in 1887) to be due chiefly to oxygen and nitrogen, by photographing the spark spectra of metals in gaseous compounds composed of those elements—as, for instance, in nitrous oxide. But the spark spectrum of air, as photographed, mapped, and described by Hartley and Adeney, contains various lines which could not be attributed to oxygen or to nitrogen nor to any other substance (*Phil. Trans.*, 1884, clxxv., 63). It had been observed that many of the atmospheric lines were subject to variations according to circumstances which were completely under experimental control, but that aluminium, indium, and copper electrodes yielded air spectra with some lines more sharply defined and distinct and more prominent than others (*Journ. Chem. Soc.*, 1882, xli., 84).

These facts were again studied in 1887 and 1890, but reserved for a more complete examination. In the year 1894 it was announced that Lord Rayleigh and Sir William Ramsay had separated a new element from the atmosphere. A proof of their paper, in advance of its publication, was forwarded to me from the Royal Society on January 29th, 1895; this contained a description of the spectrum of argon by Sir William Crookes. All the lines he had measured of greater refrangibility than wave-length 4629·5 were found in Hartley and Adeney's photographed spectrum of air, published in 1884.

Fifty or these air lines, out of a total of 195, which had been proved not to belong to oxygen or nitrogen (*Proc. Roy. Soc.*, 1895, lvii., 193) were identified with argon lines. This fact, with the actual wave-lengths of the lines, was communicated to the Royal Society at the same meeting at which the papers describing the discovery of argon were read. A letter from the Secretary at that time, Lord Rayleigh, now President of the Royal Society, informed me that my communication had been recognised as independent evidence of the existence of argon in the atmosphere. Eighteen days later I pointed out that the conditions as to pressure of the argon, and the nature of the electrodes used in photographing the spectrum of air, were very nearly those under which the brightest and purest spectrum of argon had been obtained. The spectrum of argon, then, had undoubtedly been photographed, and many of the lines accurately measured, along with those of oxygen and nitrogen, for the first time in the laboratory of the Royal College of Science, Dublin, and published ten years before its existence was announced by its actual discoverers.

A most complete investigation of the argon spectrum was made by Professors Eder and Valenta, and published in Vienna in 1896. On the accompanying table are shown the wave-lengths and descriptions of the lines in question, compared with the corresponding measurements by Crookes and by Eder and Valenta. Eder and Valenta's were made with a Rowland concave grating of 30 inches focus, and those of Hartley and Adeney with a Rutherford plane grating of 17,296 lines to the inch and quartz lenses of 36 inches focus.

Without the aid of photography it would have been impossible to establish the fact that the spark spectrum of air contained fifty lines which did not belong to the spectra of any of its known constituents.

The fact that argon gave two different spectra was considered to be evidence to the effect that there were two substances in argon, and therefore it was a compound. Evidence to the contrary was—(1) that many substances have two different spectra, and that there had been photographed on the same plate, simultaneously from the same spark discharge, the two different spectra of nitrogen; (2) that there were no gaseous substances known which could withstand the high temperature of the condensed electric spark without exhibiting the spectrum of one or other of the elements of which it is composed. It was even argued that it was probably a modified form of nitrogen, even as ozone is a modification of oxygen. But as the spectrum of argon of either the blue or the red modification was not that of any known substance, it followed that if argon were a compound it must be a compound of a new element.

That which was described as the true distinction between a compound and an elementary substance, with special reference to argon, has been recognised as the criterion of an elementary form of matter by the International Congress for Pure Chemistry, which met in Paris in 1900.

The absorption properties of the constituent gases and vapours in the earth's atmosphere causes the limitation of the solar spectrum, and the late M. Cornu, of Paris, showed that this limitation diminishes regularly when photographs are taken at increased altitudes, up to 2570 metres above the sea-level. In 1881 each of the minute constituent substances known at that time to be present in the air was examined, and the absorption effect on the ultra-violet spectrum of small quantities of each of them was carefully determined. The one substance which in minute quantities was found to cause the greatest amount of absorption was ozone, and varying quantities above a certain limit caused the spectrum to be shortened almost exactly at the same point which was described as being the maximum absorption of ozone. This position coincided with the extreme end of the solar spectrum. The conclusion arrived at was —that neither dust in the atmosphere, nor the vapour of

* A Paper read at the Sixth International Congress of Applied Chemistry, Rome, April 28th, 1906.

water, nor carbonic acid, nor any other vapour or gas in the atmosphere, save and except ozone, could cut off the sun's rays at almost the same wave-length, and ozone must, therefore, be considered to be the cause of the limitation of the solar spectrum (*Journ. Chem. Soc.*, 1881, xxxix., 111).

The absorption capacity of ozone by the ultra-violet rays, within the range of wave-lengths 1850 and 3000, was recently measured by Dr. Edgar Meyer with Kreusler's photometer ("Uber die Absorption der Ultra-violetten Strahlung in Ozon," Inaugural Dissertation, Berlin, 1903). He detected the absorption band, and located its greatest intensity at almost exactly the same point as was shown by my photographs. He also arrived at the same maximum of absorption.

An analytical problem connected with the composition of the Dublin gas supply was in the first instance solved by the spectrograph. Coal-gas and oxygen burnt together in a blowpipe yielded flame spectra in the photographs of which some of the groups of bands characteristic of cyanogen were identified. Dr. Eder, to whom we are indebted for so many and valuable spectroscopic and photographic researches, expressed doubts as to these bands being due to cyanogen, and accordingly very delicate chemical tests were applied to the coal-gas which proved absolutely the presence of cyanogen compounds in quantity quite sufficient to render its spectrum on a photographic plate.

*The Spectrographic Analysis of Alloys by means of the Spark.*

The quantitative spectrographic analysis of articles of ancient jewellery and coins is performed without removing any visible portion by cutting, filing, or dissolving in acids. Here are three examples of a Roman coin with the inscription Augustus Fortunatus, a Greek one of Alkibiades, and an obsolete French coin. The method of spectrographic analysis is extremely simple. A spark is passed from the coin to a piece of graphite and its spectrum photographed. The lines of the metals present are identified by comparison with the spectra of pure substances. The wave-lengths of the lines are measured, and the lines belonging to the different constituents are sorted out. The lines recorded indicate the composition of these two coins.

The Roman coin is a fine bronze, containing copper and tin with a trace of iron. The Greek one is peculiar, as, besides copper and tin, it contains lead and a larger proportion of iron. The coin itself has a peculiar golden colour. The composition of the "sou blanc" is of interest, as in some particulars it resembles the Greek coin. Neither tin, gold, nor silver was found—in fact, the coins were remarkably free from the latter metal. Its percentage composition is—lead, 13·96 per cent; copper, 72·35 per cent; zinc, 12·70 per cent; and iron, 0·85 per cent.

An alloy of this composition was made in the laboratory and rolled out; its spectrum corresponded exactly with that of the coin, in the length, strength, and number of lines belonging to the respective metals. The quantitative composition of the alloy was then determined by the usual methods of chemical analysis, and the spectrographic analysis was proved to be correct.

The metal is peculiar, inasmuch as its composition is that of brass with one-third of the zinc being substituted by lead. It is apparently the large proportion of lead which gives the coin a golden colour, but prevents it having any metallic "ring." It may be remarked that the chief difference between the Greek and Roman coins is the quantity of lead in the former, and this diminishes the proportion of the copper.

A very troublesome piece of work was an investigation into the composition of brittle platinum, the metal being in the form of thin wire in pieces not exceeding 2 m.m. in length. Such fragments could not be held in metal clips for the passage of the spark, because the spark of the platinum would be contaminated by that from the clips. The difficulty was overcome by fusing pure gold wires on to the end of the platinum with a blowpipe flame, and with the gold wire as a conductor the spectrum of platinum was obtained free from any other metal. If the spark by accident happened to pass from the gold, the gold lines were easily recognised and eliminated from the platinum spectrum. Ten platinum pins were examined, and the metal was proved to be free from any metallic impurity. From other evidence it was shown to be probable that the brittleness was caused by the presence of phosphorus. This investigation proved in a forcible manner—(1) the utility for practical purposes of spectrographic analysis by means of the spark; (2) the importance of determining the wave-lengths of arc and spark lines of pure elements with extreme accuracy; and (3) the advantage of being able to distinguish between two spark lines of very nearly the same wave-length by the difference in their characters.

*Spectrographic Analysis of Minerals by means of the Oxyhydrogen Flame.*

By means of Deville's blowpipe samples of various metallic elements and their compounds are easily volatilised, and may be submitted to direct spectrographic analysis. The spectra are quite different in character from those of the spark, particularly those of the metalloids and many of the metals, such as lead, tin, copper, silver, gold, antimony, and bismuth.

Iron, cobalt, and nickel give large numbers of lines, which are a characteristic feature in the spectra of meteorites. A collection of materials from iron smelting works, with a hundred and seventy iron ores and associated minerals from every part of the world were examined by Mr. Ramage (formerly of the Royal College of Science) and myself. Unsuspected and uncommon elements were found very generally distributed through these ores in small quantities; for instance, lead, silver, copper, chromium, and nickel, also the rarer metals, rubidium, cæsium, gallium, indium, and thallium. This last element is of rare occurrence in oxide ores, but is frequently found in pyrites (*Trans. Chem. Soc.*, 1897, pp. 533 and 547; and 1900, p. 61).

Gallium was found in twenty-one out of fifty-one clay ironstones, and in all aluminous minerals, such as clays and bauxites, even corundum. The siderites (ferrous carbonates) contain indium but no gallium, and the magnetites contain gallium but no indium. The red hæmatites are remarkable above all other iron ores for their purity.

From 375 grms. of the blast-furnace iron from the North-Eastern Steel Works at Middlesbrough, in Yorkshire, there was extracted 0·0235 grm. of gallium sesquioxide. Undoubtedly the richest source of gallium now known is the pig-iron and steel rails made in the Cleveland district of Yorkshire. It contains one part of metallic gallium in from 30,000 of iron.

The thermo-chemistry of the Bessemer process was studied by photographing the spectra of the flames issuing from the mouth of the vessels in which molten raw iron is converted into steel. The flames exhibit peculiarities in different works according to the variations in the process and the materials used. Photographs being taken every successive half minute, the lines were seen to become increased in number, length, and strength as the "blow" progressed, and the temperature of the metal and the flames increased largely.

*The Examination of Atmospheric Dust.*

In 1874, Baron A. E. Nordenskiöld described three different kinds of dust collected by him. Two of these, which were found on the ice in the Artic regions, were evidently of terrestrial origin, and could be accounted for, but the third variety was quite different, and appeared to be of cosmic origin. He arrived at the conclusion that this was meteoric dust, and that such was continually falling.

Small quantities of matter which had been precipitated from the atmosphere in snow, hail, and sleet, were submitted to spectrographic analysis by Mr. Hugh Ramage and me, and it was found that they contained the metallic constituents of meteorites. Pumice from the eruption of

*Lines in the Spectrum of Argon Photographed by Hartley and Adeney in 1884, compared with those of Crookes and of Eder and Valenta measured in 1895-96.*

| Crookes, 1895. | | Hartley and Adeney, 1884. Hartley, 1887—1890. | | Eder and Valenta, 1895-6. |
|---|---|---|---|---|
| Blue. Wave-lengths. | Red. Wave-lengths. | Wave-lengths. | Description. | Wave-lengths. |
| — | 4629·5 | 4628·9 | Strong | 4628·60 |
| 4608 | — | 4605·6 | Weak | 4609·74, 4602·63 Two lines; the mean is 4606·72. |
| — | 4594·5 | 4595·0 | Weak | 4596·30 |
| — | 4586·9 | 4589·3 | Weak | 4590·05 |
| — | 4534·5 | 4543·4 | Faint | 4545·26 |
| 4509·5 | 4509·5 | 4506·6 | Weak | 4503·15 |
| — | 4478·3 | 4476·6 | Weak, fine | 4475·15 |
| — | 4426·5 | 4425·9 | Weak, nebulous | 4426·16 |
| — | 4399·5 | 4402·6 | Faint | 4401·19 |
| — | 4376·5 | 4378·0 | Faint | 4379·79 |
| — | 4348·5 | 4348·2 | Strong | 4348·11 |
| 4345·0 | 4345·0 | 4343·9 | Weak, fine | 4343·90 |
| 4333·5 | 4333·5 | 4335·9 | Faint | 4335·42 |
| — | — | 4330·8 | Faint | 4331·35 |
| 4300·5 | — | 4302·0 | Very faint | 4304·03 (Kayser). |
| — | 4277·0 | 4275·3 | Faint, nebulous | 4275·34 |
| — | 4272·0 | 4274·3 | Very faint, sharp | 4272·29 |
| — | 4266·0 | 4265·4 | Very faint | 4266·44 or 4265·80 |
| — | 4251·5 | 4253·4 | Faint | 4251·27 |
| — | 4228·5 | 4228·9 | Fairly strong, nebulous | 4228·27 |
| — | 4198·0 | 4197·9 | Faint, nebulous | 4198·40 |
| — | 4191·5 | 4189·3 | Weak, sharp | 4190·85 |
| — | (4150·5) | 4157·9 | Very faint, nebulous | 4158·60 |
| 4131·5 | — | 4132·8 | Fairly strong, fine | 4131·95 |
| 4105·0 | — | 4104·3 | Fairly strong, fine | 4104·90 or 4104·10 |
| — | — | 4102·6 | | |
| 4072·5 | — | 4071·4 | Strong, fine | 4072·18 |
| 4033·0 | — | 4034·4 | Weak, nebulous | 4033·99 |
| 3967·8 | — | 3967·3 | Faint, fine | 3968·50 |
| 3943·5 | — | 3944·5 | Faint, nebulous | 3944·50 |
| 3931·8 | — | 3933·9 | Very faint | 3932·71 |
| 3928·5 | — | 3929·0 | Very faint | 3928·78 |
| 3892·0 | — | 3892·4 | Very faint | 3892·15 |
| 3851·5 | — | 3850·0 | Faint, fine | 3850·70 |
| 3803·5 | — | 3804·0 | Faint, fine | 3803·38 |
| 3780·8 | — | 3782·1 | Faint, fine | 3781·50 |
| 3770·5 | — | 3771·5 | Faint, fine | 3771·58 |
| 3738·5 | — | 3739·7 | Very faint, fine | 3738·04 |
| 3729·8 | — | 3726·6 | Strong, fine | 3725·67 (Kayser). |
| 3587·0 | — | 3589·6 | Weak, fine | 3588·94 |
| 3580·3 | — | 3583·7 | Weak, fine | 3582·72 |
| 3575·0 | — | 3576·2 | Weak, fine | 3576·80 |
| 3560·0 | — | 3560·6 | Weak, nebulous | 3560·15 |
| 3544·5 | — | 3544·2 | Weak, nebulous | 3545·78 |
| 3513·5 | — | 3514·1 | Very faint, fine | 3514·53 |
| 3490·0 | — | 3490·7 | Weak, fine | 3491·71 |
| 3475·7 | — | 3478·1 | Faint, fine | 3478·40 |
| 3453·5 | — | 3456·2 | Very faint, fine | 3454·30 |
| 3388·0 | — | 3389·9 | Fairly strong, fine | 3390·05 |
| 3042·7 | — | 3042·5 | Faint, fine | 3046·15 |
| 2734·5 | — | 2733·2 | Faint, fine | 2732·67 |

Krakatoa, which occurred in 1883, was also examined. Dust which fell into porcelain dishes placed on the grass, open to the sky, contained carbonaceous particles which looked steel-grey and were magnetic. Particles of soot were easily washed away, and the heavier particles were spectrographically analysed. Soot from various chimneys, and flue-dust from chemical and metallurgical works was examined. Several metallic and stoney meteorites were also examined. The dust which had fallen directly from the clouds was distinguished by its regularity in composition; it appeared to contain the same proportions of iron, nickel, calcium, copper, potassium, and sodium. Volcanic dust differed from this in several particulars. Dust from sleet, snow, and hail suddenly precipitated from dark clouds again differed, and the difference was chiefly in the proportion of lead present, which in the dust from sleet was found to be much larger than in the other specimens. The conclusion arrived at was, that the dust which fell in November, 1897, was certainly meteoric, and that which fell in hail and sleet was of terrestrial origin, and most probably the product of chemical or metallurgical works. It was unlike flue-dust and not like soot in composition. The inference was that some of it was fume, such as is seen rising from the mouth of the Bessemer vessels. It was observed also that some of this dust contained a large proportion of lead.

The works near Dublin are not capable of causing dark patches in the sky at a very great elevation such as were seen before each of these storms. Whence came this fume? These darkening hazes in the sky were noticed always in an easterly or south-easterly direction. In South Wales, in the neighbourhood of Swansea, there is the largest group

of metallurgical works in the United Kingdom, where copper and lead are smelted and refined, and iron ores are smelted and the metal converted into steel. In the Vale of Dowlais clouds of fume arise from the Bessemer converters to a height of 300 or 400 feet in an unbroken column; the fume then rolls over and diffuses into the atmosphere, and with an easterly movement of the air, it disperses itself slowly over a large area, and is borne away across St. George's Channel. Besides the South Wales district we have the manufacturing districts, known locally as the "*black country*," and "*the potteries*" of Staffordshire, also the chemical works of Lancashire, all contributing such fume, which passes over the Irish Sea when an easterly wind prevails, and travels into the interior of Ireland.

It might be supposed that the chemical works at the river-side, near Dublin, may have contributed flue-dust, but that was proved not to be the case, for flue-dust from the Dublin chemical works is distinguished by containing the metal indium, and none of the samples of dust from hail, rain, or sleet contained any trace of this element.

Among other questions which have been solved by spectrographic analysis is the cause of the colour in slate. Three varieties were taken from the Bethesda quarry in North Wales, green, reddish purple, and blue in colour. The green colour was found in patches, and in every case where these patches occurred, the colour was undoubtedly due to copper, either as basic carbonate or silicate. The reddish purple slates were found to be coloured by a manganese silicate, and the blue slates, in addition to manganese, contained a notable quantity of cobalt silicate. The direct analyses of galena found in Crossmaglen, Ireland, were made, chiefly to ascertain whether it contained any payable quantity of silver, for the information of the Department of Agriculture and Technical Instruction. Quantities of a gramme were burnt for each photograph, but the lines of silver were so faint that the ore was reported to be of no value. A larger quantity was assayed in the usual manner, and the result led to the same conclusion. Associated with the galena was a cream-coloured massive crystalline mineral which, when spectrographically examined, proved to be very pure lead sulphate containing only a trace of potassium and a little copper, with a total absence of silver.

The unexpected occurrence of nickel in certain rocks, of strontia in a marine boiler incrustation, to the amount of 1 per cent, of lithia, and of beryllia in some of the granites and granitic rocks around Dublin have been proved by spectrographic analysis. For the examination of the absorption spectra of the rare earths, for testing methods for the separation of metals in quantitative analysis, and for determining the composition of small precipitates obtained in the analytic separation of substances, the spectrographic method is invaluable. I venture to predict that when the methods of working, and the practical details are more widely known, the spectrograph will become an indispensable instrument to the chemist, whether engaged in mineral analysis or occupied with organic research. Quartz and calcite are the only materials of use at present; the Jena ultra-violet glass when cut into a prism of 60°, transmits only so far as wave-length 3283 (Cd. 12); with calcite wave-length 2194, and with quartz wave-length 2025, are easily photographed.

**Formation of Dipeptides by the Hydrolysis of Proteins.**—Emil Fischer and Emil Abderhalden.—On hydrolysing silk fibroin with strong cold sulphuric acid or hydrochloric acid a dipeptide of glycocoll and *d*-alanine is obtained, and can be isolated in the form of anhydride. Similarly, when other proteins are used other dipeptide anhydrides are obtained. Of these the authors have prepared two, one composed of *l*-tyrosine and glycocoll, while the other contains glycocoll and active leucine. The first of these new compounds is glycyl-*l*-tyrosine anhydride, and the second (which was obtained from elastine) is glycyl-*l*-leucine anyhdride.—*Berichte*, xxxix., No. 10.

## MOLECULAR CONDUCTIVITIES: QUANTITATIVE RELATION.

By PHILIP BLACKMAN.

It was shown by the author that there exists a "Quantitative relation between molecular conductivities" (*Phil. Mag.*, 1906, xi., 416). Out of 195 quantities used in constructing the table in that paper, 185 were drawn from an 1893 edition of Landolt-Börnstein's "Physikalische-Chemische Tabellen" and the remaining ten from the 1905 edition.

The following table (in which 264 molecular conductivity numbers have been employed for its construction) is entirely constructed from the data in the 1905 edition.

| $v$ (at 18°) = | 1000 | 500 | 200 | 100 | 50 | 20 | 10 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|---|
| K′HCl .. | 484 | 473 | 479 | 466 | 472 | 463 | 452 | 422 | 387 |
| K″HCl .. | 475 | 475 | 473 | 471 | 469 | 463 | 454 | 420 | 384 |
| K‴HCl .. | | | | 470 | | | 444 | 400 | 367 |
| K′½$H_2SO_4$ .. | 468 | 461 | 442 | 426 | 409 | 377 | 350 | 323 | 310 |
| K″½$H_2SO_4$ .. | 459 | 451 | 433 | 415 | 395 | 368 | 342 | 328 | 304 |
| K‴½$H_2SO_4$ . | | | | 413 | | | 332 | 296 | 285 |
| K′$HNO_3$ .. | 485 | 484 | 480 | 478 | 474 | 466 | 458 | 432 | 413 |
| K″$HNO_3$ .. | 477 | 477 | 475 | 473 | 469 | 465 | 458 | 424 | 401 |
| K′$CH_3CO_2H$. | 177 | 165 | 154 | 148 | 144 | 138 | 134 | 127 | 122 |
| K″$CH_3CO_2H$ | 171 | 160 | 152 | 147 | 144 | 141 | 139 | 127 | 117 |
| K′½$H_2C_2O_4$.. | 292 | 284 | 276 | 273 | 260 | 250 | 235 | | 170 |

$$K'HCl = \mu_v HCl + \mu_v KOH - \mu_v KCl,$$
$$K''HCl = \mu_v HCl + \mu_v NaOH - \mu_v NaCl,$$
$$K'''HCl = \mu_v HCl + \mu_v LiOH - \mu_v LiCl;$$

$$K'\tfrac{1}{2}H_2SO_4 = \mu_v \tfrac{1}{2}H_2SO_4 + \mu_v KOH - \mu_v \tfrac{1}{2}K_2SO_4,$$
$$K''\tfrac{1}{2}H_2SO_4 = \mu_v \tfrac{1}{2}H_2SO_4 + \mu_v NaOH - \mu_v \tfrac{1}{2}Na_2SO_4,$$
$$K'''\tfrac{1}{2}H_2SO_4 = \mu_v \tfrac{1}{2}H_2SO_4 + \mu_v LiOH - \mu_v \tfrac{1}{2}Li_2SO_4;$$

$$K'HNO_3 = \mu_v HNO_3 + \mu_v KOH - \mu_v KNO_3,$$
$$K''HNO_3 = \mu_v HNO_3 + \mu_v NaOH - \mu_v NaNO_3;$$

$$K'CH_3CO_2H = \mu_v CH_3CO_2H + \mu_v KOH - \mu_v CH_3CO_2K,$$
$$K''CH_3CO_2H = \mu_v CH_3CO_2H + \mu_v NaOH - \mu_v CH_3CO_2Na;$$

$$K'\tfrac{1}{2}H_2C_2O_4 = \mu_v \tfrac{1}{2}H_2C_2O_4 + \mu_v KOH - \mu_v \tfrac{1}{2}K_2C_2O_4.$$

The above table, in conjunction with the following table of percentage "Relative Strengths of Acids" (Chemical News, 1906, xciii., p. 284), has been used in the calculation of the "Atomic Conductivities of the Ions" (*Phil. Mag.*, 1906, xii., p. 150).

| $v$ (at 18°) = | 1000 | 500 | 200 | 100 | 50 | 20 | 10 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|---|
| HCl . .. | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| $HNO_3$ .. | 99·4 | 99·4 | 99·5 | 99·5 | 99·2 | 99·2 | 99·7 | 99·0 | 100 |
| ½$H_2SO_4$.. | 95·9 | 93·4 | 88·5 | 80·5 | 77·9 | 70·3 | 64·1 | 62·4 | 62·6 |
| ½$H_2C_2O_4$. | 48·0 | 46·0 | 43·9 | 42·7 | 38·9 | 36·9 | 33·3 | 23·2 | 19·8 |
| $CH_3CO_2H$ | 10·9 | 8·0 | 5·4 | 3·9 | 2·8 | 1·8 | 1·3 | 0·6 | 0·4 |

East London Technical College,
London, E.

**Sale of Widnes Chemical Works.**—The business and plant of Hadfields, Ltd., Chemical Manufacturers, of Weston Point, Cheshire, was put up for auction on Sept. 20th by Mr. George Gaunt, of Liverpool, acting on instructions of Mr. T. S. Sheard, the Receiver appointed by the Court of Chancery. It was sold as a going concern for the sum of £2500. The business and property had been for some time past for sale by private treaty, but no "deal" was arrived at. The auction was interesting as a practical test of value. A number of buyers from all parts of the Kingdom attended with a view of picking up details, but the sale *en bloc* prevented their object being attained.

## THE DETERMINATION OF SILICA.

By N. KNIGHT and F. A. MENNEKE.

Dolomite rock (containing silica) and ores of iron and manganese were treated with different acids as solvents, and the resulting insoluble residue was studied. The purpose of the work was to ascertain the treatment which would leave the smallest amount of residue, and therefore the purest form of silica. In some cases the nature of the residue other than silica was investigated.

Each specimen studied was finely ground with agate mortar and pestle, until the powder did not feel gritty when placed between the teeth, and was then thoroughly mixed. About a grm. of the powder was used in each determination.

*Siderite.*

1. *a.* The powder was placed in a beaker and covered with a watch-glass. It was dissolved with pure dilute hydrochloric acid (equal parts hydrochloric acid of sp. gr. 1·20 and water) by carefully heating to boiling. The insoluble residue was found to be 6·06 per cent. This was transferred to a weighed platinum crucible and treated with sulphuric and hydrofluoric acids; the loss of weight, representing the silica, was 1·44 per cent. A blank test was made of the sulphuric and hydrofluoric acids used, and no residue was left on their evaporation. The filtrate from the insoluble residue was evaporated on the water-bath, and as crystals began to appear the mass was stirred with a glass rod flattened on the end, until a fine dry powder resulted. This, on treatment with concentrated and dilute hydrochloric acid and afterwards with water, gave no residue.

*b.* A grm. of the fine powder was placed in a small porcelain evaporating dish and dissolved on the water-bath with dilute hydrochloric acid. It was stirred to a fine dry powder, as in the filtrate under *a*. This, on receiving the usual treatment with hydrochloric acid and water, gave an insoluble residue of 6·07 per cent. After treatment with sulphuric and hydrofluoric acids, 1·45 per cent of silica was shown to have been present. The residue in the crucible, which had the appearance of iron, was dissolved in concentrated hydrochloric acid and the iron precipitated with ammonia; 4·64 per cent $Fe_2O_3$ was obtained. This comparatively large amount of insoluble residue, practically the same by both tests, was somewhat of a surprise. The amounts of the iron oxide and silica are not in the proper ratio to form a silicate; or, at best, only a portion is silicate, the rest seems to be iron oxide in such a condition as not to be acted upon readily by hydrochloric acid. The next two experiments tend to confirm this view.

*c.* Method *a* was repeated, except dilute nitric acid (equal parts nitric acid of a specific gravity of 1·42 and water) was substituted for the hydrochloric acid. This leaves a much smaller and lighter coloured portion than the hydrochloric acid. The insoluble residue was 1·336 per cent, which proved to be 1·30 per cent silica. On evaporating the filtrate to dryness, a second portion of insoluble residue was not obtained.

*d.* Method *b* was repeated, using dilute nitric acid. The insoluble residue was 1·30 per cent, the silica being 1·28 per cent. On second evaporation no residue appeared.

The experiments were repeated, using dilute sulphuric acid. The results were unsatisfactory, as the residues obtained were abnormally large, confirming the well-known fact that the ores of iron are not easily soluble in sulphuric acid.

A complete analysis of this specimen of ore resulted as follows:—

| | |
|---|---|
| $Fe_2O_3$ | 52·59 |
| FeO | 4·20 |
| MnO | 3·30 |
| MgO | 2·68 |
| CaO | 0·82 |
| $SiO_2$ | 1·45 |
| $CO_2$ | 35·00 |
| | 100·04 |

2. Another specimen of siderite was examined and treated by each of the four different methods described in the foregoing. The following figures were obtained:—

| | *a.* | *b.* | *c.* | *d.* |
|---|---|---|---|---|
| Residue (per cent) | 1·33 | 1·26 | 0·85 | 0·94 |
| $SiO_2$ (per cent) | 0·91 | 0·86 | 0·80 | 0·85 |

The residue was obtained by evaporating the filtrates in the foregoing experiments.

3. A third specimen of siderite was available for examination, and it was subjected to the same treatment as before, with the following results:—

| | *a.* | *b* | *c.* | *d.* |
|---|---|---|---|---|
| Insoluble residue (per cent) | 0·40 | 0·36 | 0·40 | 0·38 |
| $SiO_2$ (per cent) | 0·36 | 0·31 | 0·35 | 0·32 |

The three specimens were purchased of the dealers, and we regret our inability to give the locality from which they were obtained.

*Dolomite.*

(Specimens from Linn County, Eastern Iowa).

| | | *a* | *b.* | *c.* | *d.* |
|---|---|---|---|---|---|
| 1. | Insoluble residue (per cent) | 0·83 | 0·89 | 0·88 | 0·83 |
| | $SiO_2$ (per cent) | 0·50 | 0·64 | 0·62 | 0·60 |
| 2. | Insoluble residue (per cent) | 0·54 | 0·55 | 0·58 | 0·56 |
| | Silica | 0·41 | 0·42 | 0·41 | 0·41 |

When the dolomite is treated with nitric acid, it is impossible to stir the substance to a dry powder, the large amounts of calcium and magnesium nitrates interfering seriously with the drying.

In the following determinations, a second portion of residue was obtained in nearly every case. It was impossible to dissolve the substances in nitric acid, and aqua regia was substituted. The results from the different methods are not all concordant.

*Hæmatite.*

| | *a.* | *b.* | *c* (aqua regia). |
|---|---|---|---|
| Residue (per cent) | 2·26 | 2·52 | 3·19 |
| Residue from filtrate (per cent) | 0·71 | 0·22 | 0·00 |
| Silica from first residue (per cent) | 1·94 | 2·23 | — |
| Silica from second residue (p. c.) | 0·65 | 0·22 | — |
| Total silica obtained (p. c.) | 2·59 | 2·45 | 2·90 |

*Magnetite.*

| | *a.* | *b.* | *c* (aqua regia). |
|---|---|---|---|
| Residue (per cent) | 5·76 | 6·47 | 11·69 |
| Residue from filtrate (per cent) | 0·96 | 0·30 | 0·30 |
| Silica from first residue (p. c.) | 1·44 | 2·53 | 3·09 |
| Silica from second residue (p. c.) | 0·96 | 0·30 | 0·30 |
| Total silica (per cent) | 2·40 | 2·83 | 3·39 |

*Limonite.*

| | *a.* | *b.* |
|---|---|---|
| Residue (per cent) | 2·25 | 3·68 |
| Residue from filtrate (per cent) | 1·66 | 0·12 |
| Silica from first residue (per cent) | 2·12 | 3·52 |
| Silica from second residue (per cent) | 1·40 | 0·12 |
| Total silica (per cent) | 3·52 | 3·64 |

*A Specimen of Commercial Manganese Dioxide.*

| | *a.* | *b.* |
|---|---|---|
| Residue (per cent) | 12·76 | 13·95 |
| Residue from filtrate (per cent) | 1·32 | 0·12 |
| Silica from first residue (per cent) | 7·56 | 7·81 |
| Silica from second residue (per cent) | 0·42 | 0·12 |
| Total silica (per cent) | 7·98 | 7·93 |

*A Specimen of Pyrolusite.*

| | *a.* | *b.* |
|---|---|---|
| Residue (per cent) | 12·79 | 14·79 |
| Residue from filtrate (per cent) | 1·60 | 0·19 |
| Silica from first residue (per cent) | 7·92 | 7·92 |
| Silica from second residue (per cent) | 0·28 | 0·19 |
| Total silica (per cent) | 8·20 | 8·11 |

In the case of the siderites and dolomites studied, the simpler method gives results fairly concordant with the more complicated method, and the former is therefore to be preferred. A second evaporation and stirring to a dry powder gave no residue and added nothing to the value of the results. Nitric acid as a solvent of the siderites gave smaller residues than the hydrochloric acid treatment.

It is possible, as Hillebrand has pointed out (*Journ. Am. Chem. Soc.*, Nov., 1903), that, even after a second evaporation and filtration, silica may be precipitated with the iron and alumina. To obtain this amount, fusion of the iron and alumina precipitates with acid potassium sulphates and subsequent digestion with water and sulphuric acid are necessary. When the silica content of the specimen is only a few per cent, the amount that would persist in solution would necessarily be small; it would be greater in case of a determination by an alkaline fusion.

With the ores of iron other than siderite that were studied, as well as the specimens of manganese dioxide, the shorter method (simply dissolving in hydrochloric acid) gave, as a rule, as satisfactory results as the longer one.

Cornell College, September 18, 1906.

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NOTES ON

## AN ALLOTROPIC FORM OF ARSENIC

AND ON THE

## ESTIMATION OF ARSENIC WHEN IN MINUTE QUANTITIES.*

By WILLIAM THOMSON, F.R.S.E., F.I.C.

(Concluded from p. 157).

### *Influence of ½ c.c. $HNO_3$ on the Detection of Arsenic in the Form of $As_2O_5$, by the Electrolytic Apparatus when using Cathodes of different Substances.*

A SOLUTION was prepared containing 0·00000083 grm. of $As_2O_5$ in each c.c. One c.c. is equivalent to 1/10000th of a grain of $As_4O_6$ per gallon when using 50 c.c. of the liquid; 10 c.c. of this solution were mixed with ½ c.c. $HNO_3$, and introduced into the apparatus, using cathodes of different substances. The cathodes used were graphite, lead, cadmium, zinc, and iron.

After the current (3 ampères) had run for forty-five minutes the arsenic mirrors obtained were approximately equivalent to the following c.c. of the standard solution :—

(The mirrors obtained when $HNO_3$ is present are very irregular, and only admit of an approximate estimation. In each case the number of c.c. is given as the nearest whole number, and the figures represent averages from a number of experiments).

| | C c of standard solution |
|---|---|
| Graphite | 1·0 |
| Lead (*a*) | 6·0 |
| Cadmium | 2·0 |
| Zinc | 4·0 |
| Iron | 2·0 |

(*a*) Another lead cathode made by ourselves gave practically the same result, although the results showed some difference.

It is remarkable that the arsenic acid was reduced by each of the different cathodes to the condition of arseniuretted hydrogen in presence of nitric acid or some nitrous compounds, some of which remained intact after the experiment, and that lead was the most efficient.

### *Influence of different Cathodes on Arsenious Acid.*

For this series of experiments a standard solution was prepared containing 0·0000007154 grm. of $As_4O_6$ per c.c.. One c.c. is equivalent to 1/10000th of a grain per gallon when working on 50 c.c. of the solution, and 10 c.c. of the standard solution were used for each experiment, which was carried out during forty-five minutes, in each case with a current of 3 ampères.

The mirrors obtained during forty-five minutes were equivalent to the following c.c. of the 10 c.c. of the standard solution taken—the mirrors obtained with a pure zinc cathode during forty-five minutes being taken as the standard :—

| | C.c. of standard solution. |
|---|---|
| Graphite | 9 |
| Lead | 10 |
| Cadmium | 3 |
| Zinc | 10 |
| Iron | 8 |

### *Influence of different Cathodes on Arsenic Acid Solution.*

Each c.c. of the standard solution used contained 0·00000083 grm. $As_2O_5$ (=1/10000th of a grain of arsenic trioxide per gallon when using 50 c.c.).

The experiments were made as before with 10 c.c. of standard solution, and the time and electrical current as above mentioned. The resulting mirrors obtained were as follows in equivalents of c.c. of the standard arsenic trioxide solution :—

| | C.c. of standard solution. |
|---|---|
| Graphite | 1 |
| Lead | 9·0 |
| Cadmium | 2·5 |
| Zinc (*a*) | 9·0 |
| Iron | 5·0 |

(*a*) In working with $As_2O_5$ the 9 parts would be represented by the standard mirrors as 10 for that time of the experiment.

The iron electrode was made by wrapping closely round a glass tube pure fine iron wire, such as is used for making standard solutions.

Part of the arsenic seems to combine with the iron, and to form such a combination that it is not eliminated as $AsH_3$ when the current is passed. When iron which has previously been used in an arsenic test is used immediately afterwards with acid free from arsenic, it gives a perfect blank after working for forty-five minutes, but on being left till the surface oxidises, and then repeating the test with pure acid, a mirror of arsenic is obtained.

### *Insensitive Zinc in the Marsh-Berzelius Apparatus.*

When zinc contains small quantities of iron, &c., it becomes insensitive when used in the Marsh-Berzelius apparatus, *i.e.*, it gives off hydrogen free from arseniuretted hydrogen, and even when minute quantities of arsenic are added it still fails to produce a mirror. Chapman and Law (*Analyst*, January, 1906, vol. xxxi., p. 358) say that it is due to the hydrogen being given off at a lower electrical supertension, owing to the metal, existing as an impurity, being capable of liberating hydrogen at such lower super tension. They say, however, if 2 grms. of cadmium sulphate be added to the solution, that the insensitive zinc becomes sensitive. It seems remarkable that a metal such as cadmium, which liberates hydrogen at a lower super tension than zinc, should have the effect of doing away with the influence of the iron; in other words, that the deposi tion of cadmium in a spongy condition on the zinc (which is the metal dissolved by the acid) should have the effect of raising the supertension at which the hydrogen is evolved whilst the iron still remains and must presumably act as it did before the addition to it of a spongy covering. I have repeated his experiment with a sample of electrolytic zinc prepared by Brunner, Mond, and Co., which contains a small proportion of metallic iron. It retains minute quantities of arsenic added to the sulphuric acid used in the Marsh-Berzelius apparatus. We added 2 grms. of cadmium sulphate to this zinc, as recommended by Chapman and Law, and tried experiments by introducing minute quantities of arsenic into the apparatus, with and

* A Paper read before the Manchester Literary and Philosophical Society, March 13, 1906. From *Memoirs and Proceedin s of the Manchester Literary and Phi osophical Society*, vol. l., Part III.

without cadmium sulphate, but we failed to find that the cadmium sulphate made any difference. The cadmium was thrown down on the zinc, and the evolution of hydrogen much reduced thereby, but in our hands it remained as insensitive as it was before, although the strength of the sulphuric acid was increased so as to give about the same flow of hydrogen.

Chapman and Law mention, as I previously found, that magnesium is insensitive. I endeavoured to obtain magnesium free from arsenic and antimony, but failed. I took, however, the sample which contained the smallest quantity of arsenic, and made the test by dissolving completely 1·4 grms. of magnesium. The experiment was repeated with the addition to it of 0·2 grm. cadmium sulphate. In the latter case a slightly larger mirror was obtained than in the former. Four c.c. of the standard arsenic trioxide solution was then added with 1·4 grms. of magnesium, and a mirror obtained equivalent to from 2 to 2½ c.c. On repeating the experiment with the addition of 0·2 grm. cadmium sulphate, a mirror equivalent to 4 c.c. was obtained.

I dissolved 0·5 grm. of nickel in 100 grms. of pure zinc, and tried this alone; it gave no mirror. I then added 4 c.c. of standard $As_4O_6$ solution, and it gave a mirror equal to that obtained when pure zinc is employed in the manner previously recommended by me (*British Food Journal*, vol. iv., Nos. 44 and 45). On repeating this with the addition of 0·2 grm. of cadmium sulphate a mirror of about the same size was obtained. Even 1 c.c. of the standard solution (which is equivalent to 0·00000714 grm. of $As_4O_6$) gave the full mirror. Thus the zinc nickel alloy was quite as sensitive as pure zinc, although it dissolved much more readily in the sulphuric acid, and the addition of 0·2 grm. of cadmium sulphate made no difference in the size of the mirrors obtained.

We then made alloys of zinc with 0·5 grm. of cobalt, iron (in the form of wire), and copper respectively, and of these iron showed the most marked retention of arsenic, for from 20 c.c. of standard arsenic solution a mirror equivalent to about 3 c.c. was obtained, whereas cobalt and copper gave mirrors corresponding with about 20 c.c. in each case.

The addition of 0·2 grm. of cadmium sulphate increased the sensitivity of the iron alloy, a mirror equivalent to about 10 c.c. being obtained from 20 c.c. of the standard arsenic solution.

It seems to me that the action of cadmium sulphate in rendering zinc and other metals more sensitive in the determination of arsenic in the Marsh-Berzelius apparatus must be further studied.

I have pleasure in stating that I am indebted to the care and ability which has been shown by my assistant, Mr. Edwin Hopkinson, M.Sc. (Vict.), in carrying out these experiments.

## MAGNESIUM PERMANGANATE AS AN OXIDISING AGENT.

By ARTHUR MICHAEL and WIGHTMAN W. GARNER.

The use of potassium permanganate, in aqueous solution, carries with it the formation of a strong alkali, which may act in an undesired manner on the substance to be oxidised, or on the products formed in the oxidation. To obviate this difficulty it has been suggested to carry out the process in the presence of a current of carbon dioxide; or, to add magnesium chloride to the oxidising mixture and in this way render the caustic alkali inert, inasmuch as it should at once react with the chloride and form the comparatively inactive magnesium hydroxide (Lossen, *Liebig's Ann. Chem.*, cci., 370). A simpler way would be to employ magnesium permanganate as the oxidiser; moreover, the decided tendency of magnesium salts to pass over into magnesium hydroxide when heated with water, seemed to indicate that this salt should possess an unusual capacity for oxidation.

Magnesium permanganate was first prepared by Mitscherlich ("Gmelin-Kraut," Anorg. Chem., II., 2, p. 527), and later examined in his laboratory by Aschoff (*Ibid.*). They obtained the salt by treating an aqueous solution of barium permanganate with magnesium sulphate, or the corresponding silver salt with magnesium chloride, and describe it as a deliquescent, crystalline substance, with 6 molecules of water of crystallisation. Recently it has been prepared by Chambliss (Dissertation, Johns Hopkins University, 1900), by treatment of permanganic acid with magnesium hydroxide; he found that when heated on a water-bath, in aqueous solution, it is rapidly decomposed, giving off oxygen and ozone, and he also called attention to the strong oxidising power of such a solution.

We first prepared the salt by treating silver permanganate suspended in hot water with an equivalent quantity of magnesium chloride. The first method of Mitscherlich, however, gave better results. Barium permanganate (this salt is now a commercial product) was prepared from the potassium salt, according to the method of Muthmann (*Ber.*, xxvi., 1016); the aqueous solution of the barium salt thus obtained was standardised by means of oxalic acid, and the barium precipitated by the addition of the necessary quantity of magnesium sulphate. The filtrate from the barium sulphate was evaporated on the water-bath to dryness. The product thus obtained has a crystalline structure and bluish grey lustre. In order to completely desiccate the salt it was heated at 100°, in a vacuum, for several days, and it appeared to undergo but little decomposition by this treatment. Its metallic lustre was not wholly lost, though its colour changed from blue to a purplish tint, resembling that of the potassium salt. (A sealed tube containing some of the salt exploded during the summer, although it was kept in diffused light).

We found anhydrous magnesium permanganate to be insoluble in chloroform, carbon tetrachloride, benzene, toluene, nitrobenzene, ligroin, ether, and carbon bisulphide, and without action on these compounds at ordinary temperatures, unless some solvent was added to bring about solution of the salt. Methyl alcohol dissolves it in considerable quantity, forming a solution which is tolerably stable at ordinary temperatures, while ethyl and propyl alcohols are attacked instantly. The methyl and ethyl esters of acetic acid dissolve the salt to some extent, and form comparatively stable solutions. It also dissolves quite readily in glacial acetic acid, and the solution remains unchanged after several hours at room temperature. Propionic acid is attacked more readily, while butyric and isovaleric acids are decomposed with violence and with evolution of carbon dioxide. Acetone dissolves the salt, but is at once attacked with considerable evolution of heat. By way of comparison, it may be mentioned that Peau de Saint-Gilles (*Ann. Chim. Phys.*, [3], lv., 396) found that potassium permanganate is fairly soluble in acetone, and the solution is quite stable even when boiled. (Such a solution has been employed as an oxidising mixture, *vide* Sachs, *Ber.*, xxxiv., 497; Michael and Leighton, *Journ. Prakt. Chem.*, lxviii., 523). Other aliphatic ketones, which oxidised with difficulty by potassium permanganate, are at once attacked by the magnesium salt; lactic and other hydroxy acids, as well as keto acids, are also immediately destroyed. Of all the solvents examined, only two were found to be sufficiently stable toward the salt to be of any practical use for oxidation purposes, viz., glacial acetic acid and pyridine.

Dissolved in glacial acetic acid, magnesium permanganate is an extremely powerful oxidising agent. When such a solution is added to benzene, surrounded with a mixture of salt and ice, a constant current of carbon dioxide is evolved. This is a striking fact when the extraordinary stability of benzene toward other oxidising agents is taken into consideration. Carius (*Ann. d. Chem.*, cxlviii., 50) oxidised benzene with a mixture of maganese dioxide and sulphuric acid, and succeeded in isolating, besides carbon dioxide, formic, benzoic, and phthalic acids as pro-

ducts of the oxidation, but these organic acids are all instantly destroyed in the cold by magnesium permanganate in acetic acid solution, and we were unable to separate an intermediate product in the oxidation of benzene to carbon dioxide. (Carius used a mixture of 5 parts sulphuric acid to 1 of water, which dissolved some of the benzene. Although he states that no chemical action takes place when the hydrocarbon dissolves, he does not appear to have examined whether a slow chemical action does not occur).

The homologues of benzene show the same conduct towards the solution of the salt as does benzene itself. Moreover, open-chain hydrocarbons, such as hexane, which are also extremely stable towards the usual oxidising agents, are likewise readily decomposed, yielding carbon dioxide.

Potassium permanganate is almost insoluble in glacial acetic acid, but is fairly soluble in acetic anhydride, forming a solution which is only slowly oxidised on standing. (It is considerably more soluble in the anhydride than in acetone). Such a solution is, however, not to be compared with that of the magnesium salt in glacial acetic acid as regards its oxidising power. Benzene, toluene, and hexane are scarcely attacked in the cold, and even ketones are only oxidised with difficulty.

Magnesium permanganate dissolves more easily in pyridine than in glacial acetic acid, but the solution in the former solvent has surprisingly weak oxidising powers. In fact, those compounds, such as alcohol, acetone, and ethyl acetate, which are in themselves solvents for the salt, are acted on less readily in the presence of pyridine than when used alone; that is, pyridine seems to exert an inhibitory influence on the salt as an oxidiser. A solution of the permanganate in a mixture of acetic acid and pyridine is not stable, although either solvent, taken alone, forms a stable solution. Potassium permanganate is also readily soluble in pyridine, but, as in the case of the magnesium salt, the solution shows very weak oxidising powers. Methyl alcohol is more slowly attacked than when treated with the salt alone; acetone is stable, as is also ethyl acetate, while ethyl alcohol is oxidised fairly readily. Quinoline dissolves the magnesium salt, but the solution is unstable, and this base is also slowly attacked in the presence of pyridine.

From the above mentioned experiments it appears that anhydrous magnesium permanganate, in some solvents, completely destroys the benzene ring, while pyridine is attacked with very great difficulty. In the aliphatic series the higher hydrocarbons and their derivatives are oxidised very readily to carbon dioxide, whereas the lower members, particularly in the first two carbon series, are comparatively stable. The importance of the nature of the solvent used is strikingly shown in the cases of glacial acetic acid and pyridine. Not only is the pyridine solution surprisingly stable, but the inhibitory effect of the base in preventing otherwise easy oxidations is difficult to understand, especially as there is no evidence of a chemical union between it and the salt.

These preliminary experiments are suggestive along several lines. It would be interesting to ascertain whether magnesium permanganate, in aqueous solution, would show itself so destructive to aromatic substances as it does in acetic acid. That the aqueous solution will prove of use in case of difficultly oxidisable substances, and in oxidations where it is desirable to prevent the formation of an alkaline solution, seems very probable. (According to Ullmann and Uzbachian, *Ber.*, xxxvi., 1797, the calcium salt does not seem to be a more powerful reagent than potassium permanganate). Again, if substitution products of pyridine are also stable towards the acetic acid solution, the mixture will undoubtedly be of service in the degradation of the many complicated derivatives of the base. The solution of potassium permanganate, in acetic anhydride, may also prove valuable in certain oxidations, as acetic anhydride is not only a ready solvent for many substances that are difficultly soluble in water, but it acts readily on substances containing a hydroxyl or formyl group, to form products that may be less susceptible to oxidation, and the anhydride may, in this way, to a certain extent, protect the intermediary products of oxidation and enable their isolation.—*American Chemical Journal*, xxxv., No. 3.

## THE ESTIMATION OF OPALESCENT SILVER CHLORIDE PRECIPITATES.*

By ROGER CLARK WELLS.

In a recent paper upon the nephelometer (Richards and Wells, *Amer. Chem. Journ.*, 1904, xxxi., 235), a perfected form of this instrument was described and shown to be well fitted for comparing the scanty precipitates usually called opalescences. By the use of prisms the precipitates in two test-tubes could be viewed in one field of vision, and an accuracy of about 1 per cent was attained in the comparison of nearly equal opalescences. The nephelometer would appear to be a better arrangement than that described by Tswett (*Zeit. Phys. Chem.*, 1901, xxxvi., 450), because the light strikes the tube sidewise, and one can view the whole tube, instead of looking across the tube through which a pencil of light is passed. Some illustrations of the method of estimating chloride in an unknown solution were given and some general precautions mentioned, but a detailed discussion of the phenomena of opalescent precipitates was reserved for a future paper. During the frequent use of the nephelometer in the revision of the atomic weight of sodium and chlorine, the methods of nephelometry were studied and improved until they were sufficiently accurate for the special ends in view (Richards and Wells, *Journ. Amer. Chem. Soc.*, 1905, xxvii., 484). Among the facts which remained to be investigated more thoroughly, however, was the variation of opalescence with time. The present paper contains an account of experiments made upon this subject, as well as upon a great many other points which will widen the range of applicability of nephelometric methods.

Silver chloride is a very suitable salt for studying these questions. Its solubility is small in the ordinary sense, yet large as measured by the nephelometer. The presence of other salts or acids up to concentrations of about N/0·01 does not alter its solubility, or at most only very slightly. In accordance with our present theories of solution the dissolved silver chloride is, on account of the great dilution, completely ionised, and there will be, in general, a concentration of silver and a concentration of chloride which will be equal for only one special case. Moreover, it appears to fulfil the demands of the concentration law (mass action) surprisingly well, for a solution of it can be practically freed from chloride by the addition of sufficient ionised silver and from silver by the addition of ionised chlorine.

The difficulty, in previous work, was the selection of the major variables and the control of these so that only one might be varied at a time. This was a hard problem as long as two tubes were compared with each other, for one could not decide whether the observed relative variation was due wholly to the first, partly to the first and second, or wholly to the second tube. The results of this paper would not have been attained if a constant standard of reference had not been found. At first suspensions of chalk were tried, but they proved even more variable than the opalescences (Ostwald-Luther, "Physico-chemische Messungen," p. 248). Ground glass, however, appeared to be well adapted to the purpose. Ordinary window glass (plate-glass might have been better) was cut into pieces about an inch square, and these were ground by fine emery until a series was obtained which ranged from opacity to transparency. Some were ground on both sides. All were covered by black paper having

* From the *American Chemical Journal*, xxxv., No. 2.

a round hole in the centre about 16 m.m. in diameter. When such a plate was placed upon the top of the sliding tube in the nephelometer, in a definite and reproducible position, it had exactly the appearance of an opalescent precipitate. The slight colour of the window glass only heightened the resemblance. Nearly all the results in this paper, then, were obtained by comparing a single tube of opalescence with a standard glass, and it is evident that the results so obtained are more reliable than the observations published heretofore. Several of the glasses were standardised, after the needful precautions had been learned. For example, one was found by about 20 trials to be equivalent to 15·1 arbitrary units of opalescence, the extremes being 10 and 19. At first sight this does not appear to be at all accurate, but when one reflects that, under improper conditions, the readings might be as high as 45, it appears more satisfactory.

With a constant standard of reference the effect of a great many variations might have been studied. What proved to be major variables proved also to be dependent upon each other. Some of the most obvious influences are the manner of precipitating and stirring the solution. These operations were done as uniformly as possible in all the experiments. Whenever definite, very dilute solutions were prepared, by diluting more concentrated ones, or whenever small quantities of electrolytes were added, the solutions were stirred most thoroughly, and finally allowed to stand for a few minutes to make them still more uniform. During precipitation, also, they were stirred thoroughly and uniformly, usually 20 strokes, with the propeller-shaped platinum stirrers, previously described. More than 20 strokes had no further effect. Failure to stir when precipitation begins results in a noticeable alteration of the intensity of opalescence. Uniform precipitation seems to be hard to attain, but perhaps it might be regulated somewhat by using just the right concentration of precipitant. As regards light, most of these experiments were done in the dim light of a single 16-candle-power light in a dark room. Some were repeated in red light alone, but no difference was detected. When not under direct observation, all tubes stood in a box in absolute darkness. Of course the opalescences darken in daylight, but no darkening was ever certainly proved to be due to the light of the room in which experiments were performed. Even some weak opalescences exposed to the light of the nephelometer for two hours were not darkened perceptibly.

The silver nitrate employed had been sufficiently recrystallised to free it wholly from chloride. The potassium chloride had been purified by precipitation with hydrochloric acid. The nitric acid used had required three wasteful fractional distillations before it was free from chloride. The potassium nitrate had been evaporated to dryness with the addition of nitric acid until all hydrochloric acid was expelled; it was then re-crystallised from water. The sulphuric acid was boiled. Aluminium nitrate was prepared by dissolving clean strips of the metal in the pure nitric acid. Throughout the work great precautions were taken to get rid of contaminating chlorides from the air, the desk, and the hands. It is a pleasure to thank Mr. William D. Hutchinson, of Oxford University, for his kind assistance in preparing some of the standard solutions, and in making a number of the preliminary observations.

### 1. *Effect of the Medium in which Precipitation Occurs.*

When silver chloride is precipitated by mixing fairly concentrated solutions, large curds settle out, and very little opalescence is observed. In more dilute solutions, about normal for example, the addition of a silver salt to a chloride leaves a marked opalescence, but, strange to say, the addition of chloride to the silver salt results in a coagulation, and, consequently, much less opalescence. Ionised silver therefore appears to have marked coagulating power, since it is present in excess during precipitation in the latter case. Precipitation from extremely dilute solutions yields a fine state of division or suspension. This coagulates or clarifies slowly upon shaking, much faster in the presence of nitric acid. Similarly, during repeated washings of the precipitate in pure water it tends to go into an emulsion or milky state, which will not clear for days, alone, but usually clarifies by the addition of nitric acid. Now nitric acid has been shown to hasten the development of opalescent precipitates also, and one may thus infer that precipitation and coagulation are very closely related. Indeed, it is impossible to draw any line between the two phenomena—precipitation must be a process of coagulation. The object of the nephelometric experiments was therefore to attain this coagulation in a definite and reproducible fashion. It appeared reasonable to suppose that the maximum opalescence which could be attained in any way would most nearly represent the truth. For practical purposes the quickest way to attain that maximum would also be desirable. Hence, it might appear that all experiments should record a study of the speed of precipitation. They should, were it not for the fact that opalescences forming at different rates, in different media, do not necessarily attain the same intensity. Very slow precipitations appear, in general, to be swamped by superimposed effects, so that they never attain the maxima which quickly forming opalescences acquire. The variable to be controlled first in nephelometric observations, therefore, is the medium. In order to point out the effect of various media, the maximum opalescences which could be attained, without regard to the time required to attain the maximum, are here stated. Then, under a separate head, will be shown the speeds attained in the best media.

*Intense Opalescences.*

KCl (N/0·000040) precipitated by $AgNO_3$.

| | Intensity of opalescence. |
|---|---|
| In water .. .. .. .. .. .. | 21 (*a*) |
| N/0·05 $HNO_3$ . .. .. .. .. | 29 |
| N/0·05 $Al(NO_3)_3$ .. .. .. .. | 29 |
| N/0·025 $KNO_3$ .. .. .. .. | 32 |

(*a*) These numbers are merely the reciprocals of the heights of opalescence appearing equal to a glass, multiplied by 1000. They indicate intensity of opalescence on an arbitrary scale.

$AgNO_3$ (N/0·000040) precipitated by KCl.

| | Opalescence. |
|---|---|
| Without any electrolyte .. .. | 21 |
| In N/0·025 $Al(NO_3)_3$ .. .. .. | 16 |
| In dilute $H_2SO_4$ .. .. .. .. | 28 |
| In N/0·025 $HNO_3$ . .. .. .. | 30 |
| In N/0·025 $KNO_3$.. .. .. .. | 31 |
| In $HNO_3+KNO_3$.. .. .. .. | 26 |
| In $HC_2H_3O_2$ .. .. .. .. .. | 24 |

The opalescence in water alone would probably not have been so great if the traces of electrolyte produced by metathesis could have been eliminated. Hence the presence of electrolytes appears advantageous in these intense opalescences.

*Weak Opalescences.*

KCl (N/0·000007) precipitated by $AgNO_3$.

In the first experiments about a drop of fairly concentrated solutions of various salts was added to each tube. Tubes without any electrolyte attained the greatest opalescence. This was attributed to a possible greater solubility of silver chloride in the solutions containing electrolytes. It may be related to the coagulative power of ionised silver. With only traces of electrolytes, all the tubes behaved similarly. Further experiments might well be made on this case, with special regard to the proper excesses required, according to the results shown later.

$AgNO_3$ (N/0·0000040) precipated by KCl.

| | Opalescence. |
|---|---|
| In water .. .. .. .. .. .. .. | 14 |
| In N/0·025 $KNO_3$.. .. .. .. | 20 |
| In N/0·025 $Al(NO_3)_3$ .. .. .. | 18 |
| In N/0·025 $HNO_3$.. .. .. .. | 18 |
| In trace of $HNO_3$ .. .. .. .. | 18 |

A different glass was used for weak opalescences than for intense opalescences. In this case electrolytes appear to be advantageous as usual.

Experiments were also made with "actual" silver chloride solutions. The phenomena were, in general, similar to the above, except for time effects to be noted later. No better electrolytes than potassium nitrate and nitric acid for intensifying opalescence were found. The quantity to be used depends upon the amount of precipitate; it should be small with slight quantities of precipitate.

It is believed that the excesses used for precipitation in the cases above were sufficient. A full study of that matter had not been made when these results were obtained, and hence less attention was paid to it. Below are given the results bearing upon that particular question.

(To be continued).

## NOTICES OF BOOKS.

*The Laboratory Book of Mineral Oil Testing.* By Jas. A. Hicks. London: Charles Griffin and Co., Ltd. 1906.

This short laboratory guide will be useful to those who may occasionally have to test samples of oils, but are not specialists in the subject. It describes what may be called the officially recognised methods of examining mineral oils, and the author's experience in the laboratory of Sir Boverton Redwood, the adviser on petroleum to the Admiralty and Home Office, has given him unique opportunities in practical work, so that his book contains much that will be of value to the analytical chemist. The various methods of determining specific gravity with special reference to oil analysis are fully discussed, and the way to ascertain the flashing-point with the Abel petroleum tester and other testers is explained, while clear directions for measuring viscosity are given, together with a description of the Redwood viscometer. The experimental details are carefully stated, and the standard methods, which are now universally adopted in oil analysis, are fully explained in the book.

*Ausführliches Handbuch der Zuckerfabrikation.* ("Complete Handbook of the Manufacture of Sugar"). By Dr. A. Rümpler. Braunschweig: Friedrich Vieweg und Sohn. 1906.

The tenth volume of "Muspratt's Encyclopædia of Technical Chemistry" deals with the manufacture of sugar, and is as comprehensive and full of detail as the preceding volumes, which are universally recognised as almost indispensable parts of the equipment of the libraries of works, technical laboratories, and colleges. The author of this volume, Dr. Rümpler, has had long experience in sugar laboratories, and practical details are specially emphasised, complete and clear accounts of the various mechanical appliances being included. The scientific aspect is not neglected, though the chapters on the chemistry of the sugars form one of the least satisfactory parts of the book, even if the difficulty of keeping up to date such a treatise, which takes some time to get through the press, is taken into account. The analytical work in connection with sugar manufacture is treated at some length, all ordinary processes being carefully described, while the structure and cultivation of the sugar-beet, and more shortly of the sugar-cane, are also discussed. The book is undoubtedly a mine of valuable information, and may be regarded as the standard work of reference from a technical point of view.

*Elektrolytische Alkalichloridzerlegung mit Flüssigen Metallkathoden.* ("The Electrolytic Decomposition of Alkali Chlorides with Liquid Metal Cathodes"). By Dr. R. Lucion. Halle-a-S.: Wilhelm Knapp. 1906.

The greater part of this book is occupied by the alphabetical enumeration and discussion of specifications of patents relating to the electrolytic decomposition of alkali chlorides with liquid metal cathodes, taken out in England, France, Germany, Belgium, and the United States. Mercury electrodes are first considered, and some account is given of the theoretical aspects of the subject, and also of the practical difficulties which have to be surmounted, while details regarding cost of plant, output, &c., are included. The Hargreaves-Bird process, in spite of the fact that it possesses some specially interesting features and is a commercial success, is dismissed in a couple of lines, although more attention is paid to the working of the Castner-Kellner method. The second part of the book deals shortly with processes in which fused metallic cathodes are used, and the subject is attacked in the same way as in Part I., although naturally the section is much shorter and the list of patents less extensive.

## CORRESPONDENCE.

### METHYLATED SPIRIT.

*To the Editor of the Chemical News.*

Sir,—The Board of Inland Revenue have refused to grant my application for permission to use unmineralised methylated spirits in our chemical laboratory. Will you be good enough to inform me if the refusal is legal, and, if not, what steps I can take to get it rescinded.

We are an ordinary secondary day school under the Board of Education, and we have large science classes—chemistry, theoretical and practical, being taught to nearly three hundred pupils.—I am, &c.,

W. Cammack.

George Green's Schools, Poplar, E.,
September 29, 1906.

## CHEMICAL NOTICES FROM FOREIGN SOURCES.

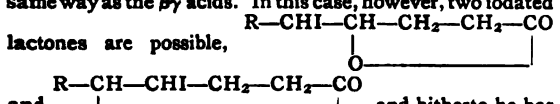
Note.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxliii., No. 10, September 3, 1906.

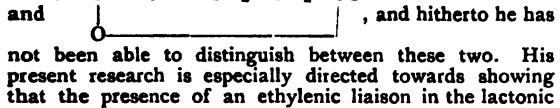
**Determination of the Fusion-points of Alloys of Aluminium with Lead and Bismuth by means of Thermo-electric Pyrometers.**—H. Pécheux.—The author determines the fusion-points of lead-aluminium and bismuth-aluminium alloys by means of two thermo-electric pyrometers: one formed of platinum and platinum-iridium (10 per cent iridium), the other of nickel-copper. These he graduates by means of a Deprez-d'Arsonval galvanometer. The curve obtained for the former couple is a parabola, and for the latter three parabolas. To obtain the fusion-points of the alloys, the hot junction of each couple is immersed in a bath of the molten alloy. The spot of light stops in its motion for some seconds when the solidification-point is reached. The numbers obtained are between 635° and 652° for lead-aluminium containing 92 to 96 per cent of aluminium, and from 650° to 720° for bismuth-aluminium containing 75 to 94 per cent of aluminium, whilst the melting-point of pure aluminium is between 626° and 630°, as determined by the same method.

**Action of Hypoiodous Acid in the Nascent State on Acids containing the Ethenylenic Function: Iodated Lactones.**—J. Bougault.—The author has already investigated the action of nascent hypoiodous acid on certain groups of acids with ethylenic function. Amongst other results, he showed that acids possessing an ethylenic liaison in $\beta\gamma$, $R—CH=CH—CH_2—CO_2H$, give,

under the conditions described, iodated lactones of formula



. He has since investigated the ethylenic acids $\gamma\delta$, and has proved that they behave in the same way as the $\beta\gamma$ acids. In this case, however, two iodated lactones are possible,



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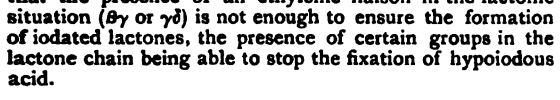

, and hitherto he has not been able to distinguish between these two. His present research is especially directed towards showing that the presence of an ethylenic liaison in the lactonic situation ($\beta\gamma$ or $\gamma\delta$) is not enough to ensure the formation of iodated lactones, the presence of certain groups in the lactone chain being able to stop the fixation of hypoiodous acid.

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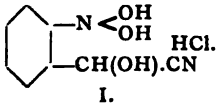
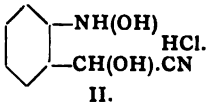
*Berichte der Deutschen Chemischen Gesellschaft.*
Vol. xxxix., No. 10, 1906.

**Spectrum of Helium from Radium Bromide.**—F. Giesel.—In a radium emanation tube first examined a year ago all the helium lines, besides hydrogen, can be observed as clearly as in a helium tube. The spectrum of this tube was taken with a spectrograph upon a photographic plate, the time of exposure being relatively short (twenty to forty minutes), and by taking the spectra of helium, hydrogen tubes, and the radium emanation tube on the same plate, the resemblances could be readily detected. Thirteen of the helium lines could be easily identified in the spectrum of the radium tube, viz., $\lambda$ 587·6, 504·8, 501·5, 492·2, 471·3, 447·2, 438·8, 414·4, 412·1, 402·6, 396·5, 388·9, 381·9.

**New Reaction Product of the Nitro-group.**—Gustav Heller.—Under favourable conditions, when nitro-compounds are reduced to amido-derivatives, nitroso and hydroxylamine compounds appear as intermediate products. Evidently the release of an oxygen atom is not the first reaction which occurs under the influence of the reducing agent, but two hydrogens are attached, and then the nitroso-group is derived from this dihydroxylamine derivative by the elimination of water, $-N\leqslant^{O}_{O} \rightarrow -N<^{OH}_{OH}$. *O*-nitromandelic acid nitrite, however, gives on reduction with zinc dust and acetic acid in the cold a compound which dissolves in dilute hydrochloric acid at the ordinary temperature without undergoing decomposition, and is separated as hydrochloride by means of fuming hydrochloric acid. This compound behaves like a molecular mixture of the hydrochloric acid salts of *o*-dihydroxylaminomandelic acid nitrile (Formula I). and of a hydroxylaminomandelic acid nitrile of Formula II. The exact way in which the two substances are combined together is not known; the author regards a quinhydrone linkage as most probable, resembling that of isatin with dioxindol to form isatyde.



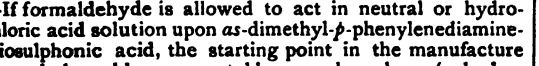
I.



II.

No. 11.

**Action of Formaldehyde upon *as*-Dimethyl-*p*-phenylenediaminethiosulphonic Acid, and a New Method of producing Benzothiazoles.**—Otto Schmidt.—If formaldehyde is allowed to act in neutral or hydrochloric acid solution upon *as*-dimethyl-*p*-phenylenediaminethiosulphonic acid, the starting point in the manufacture of methylene blue, an unstable amorphous base (anhydroformaldehydedimethyl-*p*-phenylenediamine mercaptan) is formed. When this is treated with nitrous acid, $\beta$-dimethylamidobenzothiazole is formed :—



**Compounds of Thiosulphuric Acid with Aldehydes.**—Otto Schmidt.—The author has found that formaldehyde forms a compound with thiosulphuric acid, and that the compound acid gives with anhydroformaldehydedimethyl-*p*-phenylenediamine mercaptan a well-defined crystalline salt. The formaldehyde-sulphuric acid is not stable in neutral or alkaline solution, the above salt being decomposed partially even on crystallising from hot water. The acid is, however, fairly stable in acid solution. Acidified thiosulphate solutions, to which formaldehyde has been added, only give trithioformaldehyde after standing for some hours. When such solutions are boiled, the acid decomposes almost quantitatively according to the equation $3OH.CH_2.SSO_3H = 3SO_4H_2 + (CH_2S)_3$.

**Titrimetric Determination of Formaldehyde and Formic Acid by Potassium Permanganate in Acid Solution.**—Hermann Grossmann and Arthur Aufrecht.—Lieben's method of estimating formic acid depends upon the fact that, in alkaline solution, it gives with permanganate the following reaction :—

$$2KMnO_4 + 3CH_2O_2 + KOH = KHCO_3 + K_2CO_3 + 2MnO_2 + 3H_2O + CO_2$$

This method has drawbacks; the chief being the difficulty of detecting the end of the reaction, owing to the precipitate of manganese dioxide formed. According to Vanino and Seitter, formaldehyde in acid solution is oxidised to carbon dioxide in the cold, formic acid resulting as an intermediate product. The authors find that this can be applied titrimetrically, allowing the permanganate to act for at least an hour. The equation is—

$$4KMnO_4 + 5HCOH + 6H_2SO_4 = 2K_2SO_4 + 4MnSO_4 + 5CO_2 + 11H_2O.$$

They think that, in all probability, an intermediate very labile superoxide is formed, which results from one molecule of formaldehyde, as follows :— $HCOH + O_2 = H.C.OH$ (Ö:O)

It then decomposes very readily, yielding water and carbon dioxide. The oxidation of formic acid proceeds very slowly in the cold, and even in strong sulphuric acid brown manganese dioxide separates out. Twenty-five c.c. of formic acid solution (corresponding to 0·0445 grm. of formic acid) were allowed to stand in a closed flask with 25 c.c. of one-tenth potassium permanganate (3·175 grms. per litre) and 50 c.c. of sulphuric acid (3 parts concentrated acid to 5 parts water). This mixture was allowed to stand a certain time in the dark, and then it was poured into an Erlenmeyer flask, heated to about 40°, titrated with oxalic acid till the red colour and the $MnO_2$ disappeared, then with $n/10$ permanganate till a faint red coloration was obtained. It was then found that the reaction is complete in about six hours. Salts of formic acid can be titrated as well as the free acid.

**Isoconiin, and Synthesis of Coniin.**—A. Ladenburg.—The author's experiments have shown that synthetic coniin, prepared from methyl picolylalkyl, is an isomer of *d*-coniin. Though synthetic coniin resembles *d*-coniin in almost all properties, it differs from it in its considerably higher rotatory power (about 4° difference). Synthetic coniin is undoubtedly an individual substance. The conversion of isoconiin into coniin is easily effected by heating it to about 300°.

**Decomposition of Azo-dyes with Sodium Hydrosulphite.** — Eug. Grandmougin. — If a solution of Orange II. in water is boiled and sodium hydrosulphite solution added till decolorisation is complete, on filtering and cooling the free amido-naphthol separates out in perfectly colourless flakes. The yield is the same as in the

tin salt method. To reduce benzeneazo-β-naphthol, it is dissolved in alcohol, a saturated aqueous solution of hydrosulphite added to the boiling solution till the colour is removed, and then steam is passed in. Aniline and alcohol pass over, and the amido-naphthol crystallises out from the residue. 2-Benzeneazo-α-naphthol, when treated similarly, yields 2-amido-1-naphthol, and from it the author has prepared the corresponding acetyl products, which had not previously been described. To reduce α-nitroso-β-naphthol by means of sodium hydrosulphite, a solution of the substance in alkali is used. In alcoholic solution azobenzene goes quantitatively into hydrazobenzene when treated with hydrosulphite.

**Detection of Ozone with Tetramethyldi-*p*-diamidodiphenylmethane.**—Franz Fischer and Hans Marx.—To detect ozone, and more especially to distinguish it from oxides of nitrogen when it is present only in very small quantity, the authors use paper saturated with an alcoholic solution of tetramethyldi-*p*-diamidodiphenylmethane. This paper they call tetramethyl-base paper. It is coloured violet by ozone when damp, while oxides of nitrogen colour it straw-yellow. Mixtures of oxides of nitrogen and ozone give dirty brown colorations, between violet and yellow, always supposing that the paper is kept damp. If it dries during an experiment, it may lead to serious errors; thus, dry tetramethyl-base paper is coloured yellow by ozone after about half-an-hour at the temperature of the room. To detect very small quantities of nitric oxide in presence of ozone the current of gases is led into liquid air. The ozone is then dissolved by the liquid air and the nitric oxide separates out in it as blue flakes. It is then only necessary to filter the liquid, when the frozen oxide will be found on the filter, while the ozone can be obtained by boiling the filtrate.

**Thermic Formation of Ozone and Nitric Oxide.**—Franz Fischer and Hans Marx.—The authors have investigated whether it is possible to produce ozone by thermic means from ordinary gaseous oxygen or from air. They used the following processes:—1. Combustion of hydrogen in air and in pure oxygen. 2. Glowing platinum. 3. Nernst pencils. 4. Arc lights. Their experiments show that the ozone resulting in combustion and heating processes in ordinary atmospheric air or oxygen can be obtained without any sudden cooling by means of liquefied gases. Only a certain velocity of the current of air is necessary. When hydrogen burns in air, hydrogen peroxide and nitric oxide are both formed, as well as ozone. Finally, they have shown that, by regulating the rate of the current of air, it is possible to produce so much ozone and oxides of nitrogen (especially nitric peroxide) that, with water or sulphuric acid, no nitrous acid but only nitric acid is produced.

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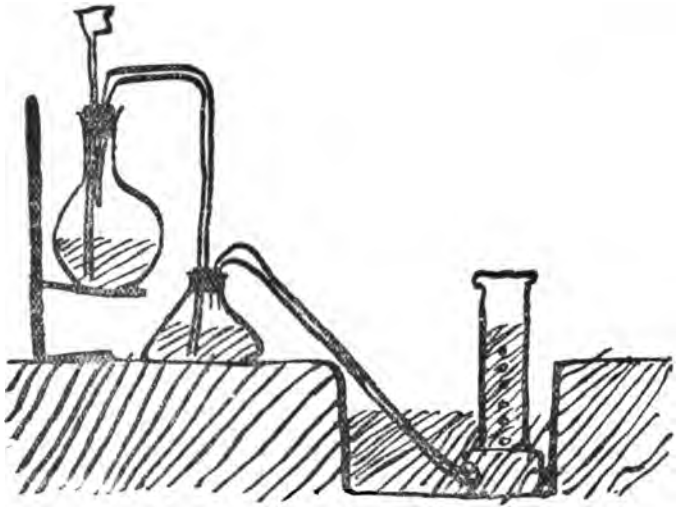

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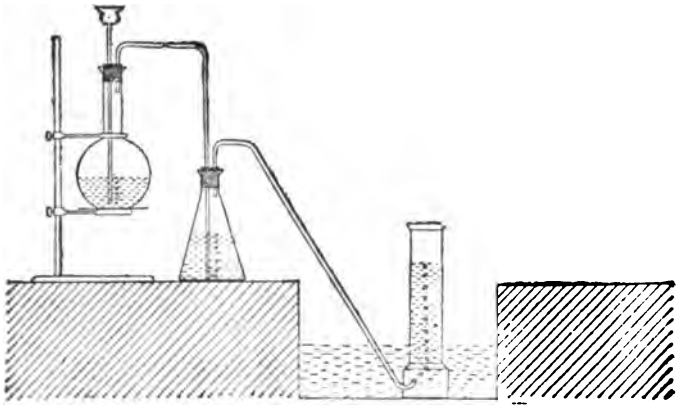

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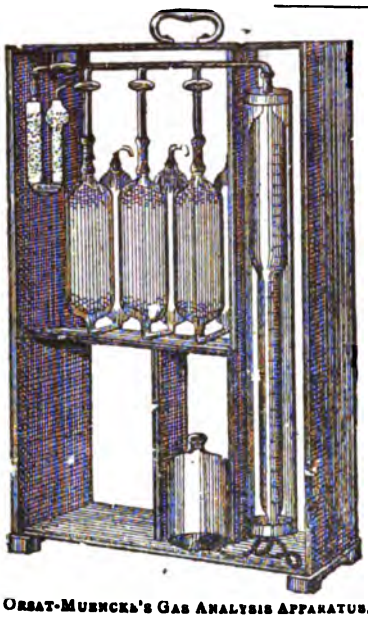

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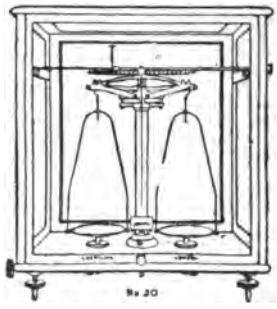

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## NEW LOW TEMPERATURE PHENOMENA.*

By Prof. Sir JAMES DEWAR, M.A., LL.D., D.Sc., F.R.S.

THE porosity of matter, and the possibility of the occlusion of gases in it, has been the subject of scientific thought for ages. As early as 1674, Boyle, under the title "Suspicions about the Hidden Qualities of Air," writes (Boyle's Works, vol. iii., p. 470, col. 1): "It may not seem altogether improbable, that some bodies we are conversant with, may have a peculiar disposition and fitness to be wrought on by, or to be associated with, some of those exotic effluvia that are emitted by unknown bodies lodged underground, or that proceed from this or that planet. . . . We may be allowed to consider whether among the bodies we are acquainted with here below, there may not be found some that may be receptacles, if not also attractives, of the sidereal and other exotic effluviums that rove up and down in our air." While other matters took up his immediate attention, this one was not lost sight of, for ten years later, in 1684, he returns to the subject in a special discourse, "Experiments and Considerations about the Porosity of Bodies," in which he says (Boyle's Works, vol. iv., p. 206, col. 1):—"When I consider how much most of the qualities of bodies, and consequently their operations, depend upon the structure of their minute and singly invisible particles, and that to this latent contexture, the bigness, the figure, and the collocation of the intervals and pores do necessarily concur with the size, shape, and disposition, or contrivance, of the substantial parts, I cannot but think the doctrine of the small pores of bodies of no small importance to Natural Philosophy." Felix Fontana, the famous physicist to Duke Ferdinand II. of Tuscany, seems to have been the first to have discovered the absorptive power of hot charcoal for gases, a property which he communicated to Priestley, about 1770, and which Priestley confirmed. Lowitz, in 1791, noticed that charcoal decolorised organic solutions. Later experiments were made by Morozzo, and another series of observations were made by two Dutch physicists, Rouppe and Norden. Shortly after this, early in last century, the subject of the action of gases on charcoal was elaborately examined by Theodore de Saussure. Subsequently, Graham and Stenhouse added valuable contributions to the inquiry. The thermal evolutions of some gaseous absorptions in charcoal were determined by Faure and Silbermann; and later, Hunter showed the advantage of using cocoanut charcoal, and made a long series of investigations on the absorption of organic vapours and gases by this variety of charcoal.

In de Saussure's experiment a piece of red-hot charcoal was plunged under mercury, and introduced into the gas to be absorbed after it was cool, without allowing it to come in contact with air. He made use of box-wood charcoal, about which he remarks that it absorbed so little mercury during the cooling that it would readily swim on water. His experiments were conducted at ordinary temperature and pressure, and gave the results in the annexed table, the unit volume being that of the absorbing charcoal. For comparison, similar experiments made by Hunter with cocoanut charcoal are given. (See Table, next column).

He found that even if the charcoal were moistened with water, it was still capable of absorbing one-third to one-half the amount of gas absorbed when quite dry.

During these experiments he called attention to the evolution of heat during absorption, and remarked that it appeared to increase with the absorbability of the gas.

| | Boxwood (Saussure). | Cocoanut (Hunter). |
|---|---|---|
| Ammonia | 90 | 172 |
| Hydrochloric acid | 85 | — |
| Sulphurous acid | 65 | — |
| Sulphuretted hydrogen | 55 | — |
| Nitrous oxide | 40 | 86 |
| Carbonic acid | 35 | 68 |
| Olefiant gas | 35 | 75 |
| Carbonic oxide | 9·42 | 21 |
| Oxygen | 9·25 | 18 |
| Nitrogen | 7·5 | 15 |
| Hydrogen | 1·75 | 4 |

In further experiments he considered the effect of pressure on the amount of absorption, and found that absorption by volume is far greater in a rare than in a dense atmosphere, but that if reckoned by weight it is more considerable than in the latter than in the former state.

(Saussure's results for carbonic acid may be represented by the formulæ $v = 15{\cdot}3 + \frac{551{\cdot}7}{p}$, $v = 19{\cdot}1 + 0{\cdot}53p$; where $v$ is the volume absorbed, measured as above, and $p$ is the pressure in inches of mercury).

He continued similar experiments with meerschaum, asbestos, and other substances, and also examined the effect of mixed gases.

Hunter examined the absorption of vapours by cocoanut charcoal at or above their boiling-points with interesting and suggestive results as regards selective action. The following table is a selection made from some of his observations:—

*Cocoanut Charcoal Absorption of Vapours at Boiling-point of Liquid (Hunter).*

| | |
|---|---|
| Carbon tetrachloride | 4 |
| Chloroform | 30 |
| Ethyl iodide | 36 |
| Alcohol | 141 |
| Benzol | 59 |
| Carbon bisulphide | 117 |
| Ether | 87 |
| Ethylamine | 127 |
| Water | 55 |

In a note read before the Royal Society of Edinburgh in March, 1874, connected with a research undertaken in association with the late Professor Tait, the absorptive power of charcoal was employed for the first time in the production of high vacua. A piece of cocoanut charcoal was placed in a glass tube, into which were sealed two platinum terminals for electric sparking. The tube was exhausted by the mercury pump, while the charcoal was at the same time heated to a red heat. On sealing off the tube, and allowing the charcoal to cool, the vacuum was so perfect that no spark would pass between the terminals, from a coil giving quarter-of-an-inch sparks in air. Similar experiments were repeated when investigating the theory of the motion of the Crookes radiometer, and are detailed in *Nature* in 1875.

One advantage of charcoal vacua in the study of electric discharges is that on heating the charcoal slowly, and connecting the platinum terminals to the induction coil, the *striæ* may be reproduced and maintained at any degree of rarefaction desired, and as often as we please.

At the Conference on May 24, 1876, in connection with the Loan Collection of Scientific Apparatus at South Kensington, I showed a further simplification and advance in the production of high vacua. A little fluid bromine was placed in a tube, and the tube was put in a water-bath, so that the bromine boiled off. Meanwhile the charcoal in another part of the tube was heated in the usual way, and when all the bromine had been vaporised the tube was sealed off. On the charcoal cooling, it absorbed the

* A Discourse delivered at the Royal Institution, January 20, 1905

bromine so thoroughly that no trace of colour was visible. In this way a vacuum is produced without the use of any exhausting pump.

Although all charcoals exhibit absorptive powers of a high order, nevertheless differences are noticeable. Among charcoals got from wood, the denser woods seem to produce the more absorptive charcoals. Thus box-wood charcoal is more absorptive than fir-charcoal. Saussure found the following relative absorptive powers from different wood charcoals :—

| | Sp. gr. | Absorption. |
|---|---|---|
| Cork .. .. .. .. .. .. .. | 0·1 | Imperceptible. |
| Fir.. .. .. .. .. .. .. .. | 0·4 | 4½ its vol. of air. |
| Box-wood .. .. .. .. .. .. | 0·6 | 7½ " |
| Russiberg coal (vegetable origin) | 1·3 | 10½ " |

But at last the porosity must become so fine that absorption again disappears. Thus, Cumberland black-lead (which is 96 per cent carbon), of sp. gr. 2·17, showed no absorption.

charcoal weighing 0·9565 grm., and thoroughly saturating it with water, he found that it weighed 2·2585 grms. in air, and 0·110 grm. under water. Hence of the gross volume of the charcoal, ⅞ was occupied by charcoal substance, and ⅛ was free space into which gases might be absorbed. Saussure found that charcoal at 12° C. and ordinary pressure absorbed 35 times its volume of carbonic acid, but as this occupied ⅛ of the gross volume of the charcoal, it was actually forced into a space equal to only $\frac{1}{28}$ of its original volume. He concluded therefore that about a third of the gas was liquefied in the pores of the charcoal. From Amagat's observations, the amount liquefied was almost exactly one-fifth).

He found that the cells of charred wood are on an average 1/2400 of an inch in diameter. Now, if a cubic inch of charcoal were cut up into a number of small equal cubes each of whose edges was 1/2400 inch, the total area of their surfaces would be 100 square feet, or taking into account the space occupied by the charcoal itself, it would leave about 73 square feet. The thickness of the liquefied

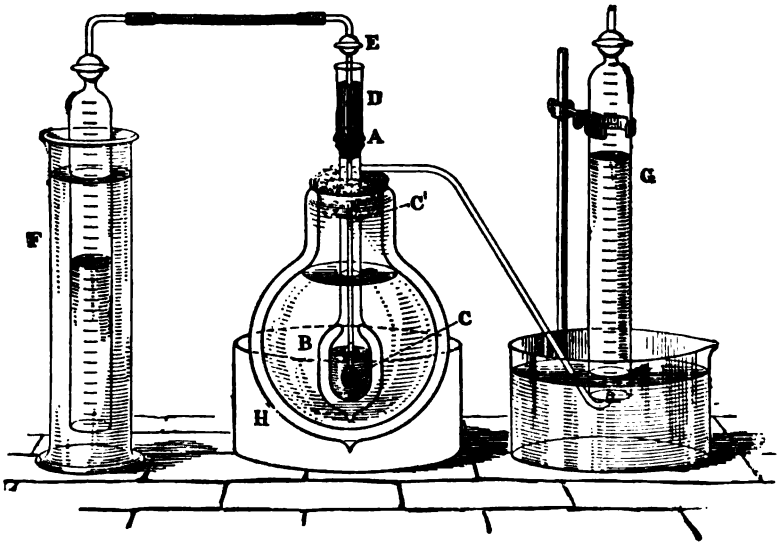


Fig. 1.

From experiments, detailed on a former occasion, undertaken to determine the effect of various substances in a state of fine division placed within the walls of vacuum vessels in protecting the contents of the vessels from external heat, by reason of bad thermal conductivity and the interference of the mean free path of the gas molecules, I found that charcoal and lamp-black were nearly equally good at the temperature of liquid air, and that each was four times as good as graphite. ("Liquid Air as an Analytic Agent," Roy. Inst., April 1, 1898).

From some recent investigations I find that charcoals so different in their origin as cocoanut charcoal and charcoal from cane-sugar differ but little in their absorptive powers for a gas like hydrogen.

Note.—Approx. : Series of 30/10/04, range 250 c.c. to 2750 c.c., gave log. $p$ = 0·08 + 0·267 c. (cocoanut); series 4/11/04, range 250 c.c. to 2250 c.c., gave log. $p$ = 0·39+0·195 c. (cane-sugar). If $p$ = 100 m.m., these give respectively c. = $\frac{2·08}{0·267}$ = 7·8 (cocoanut) and c. = $\frac{1·61}{0·195}$ = 8·3 (cane-sugar).

Mitscherlich specially studied the nature of porosity in connection with the occlusion of gases. Taking a piece of

carbonic acid over this area would, then, be about 0·000002 inch.

This harmonises to a certain extent with Saussure's remark that denser charcoals, that is, charcoals with pores of smaller diameters, and representing a greater surface for condensation, are the greater absorbers. Nevertheless, we must not forget to notice that the affinities between charcoal and different gases are not the same, and that these will seriously modify any results derived from mere geometrical considerations.

*Thermal Evolution and Absorption of Gases by Charcoal at Low Temperatures* (*Proc. Roy. Soc.*, 1904; Chemical News, xc., p. 73).

Saussure first observed and roughly noted that the absorption of gases by charcoal at the ordinary temperature gave rise to a considerable evolution of heat. The liquid air and hydrogen calorimeters can be easily arranged to afford an exact measure of the quantities of heat thus given up by the condensation of different gases in charcoal. For this purpose a small glass bulb c, containing from half a gramme to a gramme of charcoal, has a long narrow tube c′ attached, so that it can be immersed in the liquid oxygen, or air in the calorimeter A B, while still allowing a part of the tube so project above the cork A. The calori-

meter is then inserted in a large vacuum vessel H, containing 2 or 3 litres of liquid oxygen or air, as the case may be, and kept in its place by a loose stuffing of cotton-wool. In order to dry and cool the entering gas (which, in my experiments, did not exceed 40 c.c.), a little annular space is arranged at D, into which liquid air is poured immediately before the experiment begins.

The charcoal, after being placed in the small bulb C, is heated to a low red heat, and simultaneously exhausted by a good air-pump, and after all the gas has been removed, the stopcock E is closed. In this condition it is placed in the calorimeter B.

The experiment is conducted by connecting the end of the tube at E by means of an indiarubber tube with the graduated vessel F containing the gas to be examined. When all is ready the stopcock E is opened, so that the gas may rush into the charcoal, and the heat evolved by its absorption distils off the equivalent quantity of liquid air from the calorimeter B, which is then received and measured in the vessel G.

When we know the constant of the calorimeter—namely, the number of c.c. of gas evaporated by one calorie (about 14·5 c.c. in the present case)—from the readings of the two jars, F and G, we find at once the heat evolved in the condensation per unit volume of gas absorbed. After making a few necessary corrections, the results for different gases are as given in the following table:—

| | I. Volume absorbed at 0° C. C.c. | II. Volume absorbed at −185° C. C.c. | III. Ratio of II. to I. | IV. Heat evolved in grm.-calories by absorption at −185° C. |
|---|---|---|---|---|
| Helium .. .. | 2 | 15 | 7·5 | 2·0 |
| Hydrogen .. | 4 | 135 | 34·0 | 9·3 |
| Electrolytic gas | 12 | 150 | 12·5 | 17·0 |
| Argon .. .. | 12 | 175 | 14·6 | 25·0 |
| Nitrogen . .. | 15 | 155 | 10·3 | 25·5 |
| Oxygen .. .. | 18 | 230 | 12·8 | 34·0 |
| Carbonic oxide | 21 | 190 | 9·0 | 27·5 |
| Carbonic oxide and oxygen . | 30 | 195 | 6·5 | 34·5 |

To render these results comparable, the same specimen of cocoanut charcoal was used for them all, and the numbers in the last column are for absorption by 1 grm. of charcoal. The volumes of the gases absorbed are, both at ordinary and low temperatures, given under standard conditions—namely, 0° C. and 760 m.m. of mercury pressure. If it is desired to know the volumes absorbed at −185° C., when these volumes are measured at −185° C. and 760 m.m. pressure, we have only to divide the numbers in Column II. by three.

In each case, a very remarkable increase of absorption takes place at the low temperature. This is shown in Column III. It is further remarkable that the increase of absorption diminishes, roughly, as the boiling-points of the various gases increase, while Column IV. shows a corresponding increase in the quantities of heat evolved.

The general results are seen best when the values of the thermal evolution and the amount of charcoal involved are reduced to molecular volumes of the condensed gas.

*Heat Evolution.*

(Charcoal absorption per molecular volume).

| | Calories. | Weight of charcoal. |
|---|---|---|
| Hydrogen .. .. .. .. | 1600 | 206 grms. |
| Nitrogen .. .. .. .. | 3686 | 180 „ |
| Argon .. .. .. .. .. | 3636 | 162 „ |
| Oxygen .. .. .. .. .. | 3744 | 160 „ |
| Carbonic oxide .. .. .. | 3416 | 148 „ |
| Carbonic oxide and oxygen | 3960 | 144 „ |
| Electrolytic gas .. .. .. | 2414 | 180 „ |

Mean, $C_{14}M$; limit, $C_8H_2$ and $C_{12}He$.

A comparison of the molecular latent heats of the liquefied gases, hydrogen, nitrogen, and oxygen, with the charcoal heat of condensation in each case, is shown in the following table:—

| | Molecular latent heats. Calories. | Molecular absorption in charcoal. Calories. |
|---|---|---|
| Hydrogen .. .. | 238 | 1600 |
| Nitrogen . .. .. | 1372 | 3684 |
| Oxygen .. .. .. | 1664 | 3744 |

But perhaps the most striking result is the great difference in properties exhibited by helium. While resembling other cases in showing increased absorption at the temperature of liquid air, the absolute amount occluded is about one-tenth that of the other gases at the same temperature, and the quantity of heat evolved is in even a smaller ratio. We must, however, note that the position of helium on the scale of temperatures, for these experiments, is quite different from that of the other gases, even hydrogen. For helium is being absorbed at a temperature some fifteen times higher than its boiling-point (say, 6° abs.), while in the case of hydrogen this is only four and a-half times its boiling-point (20° abs.). To make a fair comparison, we should take hydrogen at fifteen times its boiling-point, which would bring us up to some 27° C.; that is, the helium absorption at −185° C. should preferably be compared with the hydrogen absorption at 0° C. The inference then is that if we had the absorption of helium at 25° to 30° absolute, we should find it show a still more remarkable condensation than hydrogen does at 90° abs. ( 183° abs.).

The following experimental results confirm this point of view:—

*Helium and Hydrogen.*

(Charcoal absorption at the temperatures of boiling and solid hydrogen.)

| Temperature. | Helium. Vols. of carbon. | Hydrogen. Vols. of carbon. |
|---|---|---|
| −185° C. (b. p. of liquid air) .. | 2½ | 137 |
| −210° C. (liquid air under exhaustion) .. .. .. .. .. | 5 | 180 |
| −252° C. (b. p. of liquid hydrogen) | 160 | 258 |
| −258° C. (solid hydrogen).. .. | 195 | |

As the relation between volume and temperature is nearly lineal at the lowest portions of either the hydrogen or helium absorption, we may infer that at the temperature of from 5° to 6° helium would be as freely absorbed by charcoal as hydrogen is at its boiling-point, and that in all probability the boiling-point of helium is not below 5° abs. This inference is quite legitimate, because good charcoal at the respective boiling-points of liquid hydrogen, nitrogen, or oxygen, absorbs at atmospheric pressure nearly the same volume of each gas, viz., 260 c.c. per grm.

It is to be noted that the rate of increase of the helium absorption is three times that of the hydrogen, so that a degree or two makes a large increase in the volume condensed. From these results it seems highly probable that the boiling-point of helium is about a fourth that of hydrogen, just as the latter is about one-fourth that of nitrogen.

In Column IV. we get the heat evolved by each gas. These values provide us with still further striking results, for the heat developed is generally greatly in excess of that required for liquefaction. Thus, for hydrogen, whose latent heat at the boiling-point I have recently determined by this calorimeter and found to be 120 grm.-calories, the liquefaction of 135 c.c. of this gas would only evolve about 1½ calories, or one-sixth of that evolved by occlusion in charcoal at the boiling-point of air. Similarly, if we take 51 grm.-calories as the latent heat of oxygen, the liquefaction of 230 c.c. of this gas would produce some 17 calories, or about half of that evolved during occlusion.

(To be continued).

## IONIC CONDUCTIVITIES AT 25°.

By PHILIP BLACKMAN.

By aid of the method advanced by the author in "Atomic Conductivities of the Ions" (*Phil. Mag.*, 1906, xii., 150), the conductivities of the ions at 25° have been calculated.* The data (of molecular conductivities of hydrates, acids, and corresponding salts at 25°) are not sufficiently numerous for the purpose of very accurate primary calculations; nevertheless, by taking the average of the respective numbers obtained by all possible substitutions, fairly close approximations to the probable values may have been obtained.

It will be noticed that the conductivities of any ion at dilutions $v = 256$ and 512 are generally almost identical; this would seem to indicate that the maximum conductivity in any case had been attained at dilution $v = 512$, and, consequently, the ionic conductivity of an ion at any dilution above 512 may be taken to be approximately equal to that at 512°.

| $v$ (at 25°) = | 32 | 64 | 128 | 256 | 512 |
|---|---|---|---|---|---|
| H .. .. .. | 350 | 355 | 360 | 360 | 362 |
| Rb .. .. .. | 88 | 90 | 94 | 96 | 97 |
| Cs .. .. .. | 87 | 90 | 94 | 96 | 97 |
| K .. .. .. | 85 | 86 | 89 | 93 | 95 |
| $NH_4$ .. .. .. | 84 | 87 | 90 | 91 | 93 |
| Tl .. .. .. | 80 | 85 | 90 | 93 | 93 |
| $\frac{1}{2}Pb$ .. .. .. | 56 | 64 | 72 | 76 | 84 |
| Ag .. .. .. | — | 72 | 74 | 76 | 76 |
| $\frac{1}{2}Cu$ .. .. .. | 61 | 63 | 68 | 71 | 71 |
| $\frac{1}{2}Ba$ .. .. .. | 59 | 65 | 68 | 70 | 74 |
| $\frac{1}{2}Sr$ .. .. .. | 59 | 64 | 67 | 70 | 71 |
| Na .. .. .. | 60 | 64 | 67 | 69 | 69 |
| $\frac{1}{2}Mg$ .. .. .. | 58 | 61 | 65 | 69 | 71 |
| $\frac{1}{2}Ca$ .. .. .. | 53 | 63 | 66 | 69 | 70 |
| $\frac{1}{2}Ni$ .. .. .. | 56 | 60 | 64 | 69 | 72 |
| $\frac{1}{2}Co$ .. .. .. | 56 | 58 | 58 | 66 | 69 |
| Li .. .. .. | 52 | 53 | 56 | 56 | 59 |
| OH .. .. .. | 150 | 153 | 154 | 154 | 155 |
| $\frac{1}{2}S_2O_6$ . .. .. | 52 | 54 | 59 | 66 | 72 |
| $NO_2$ .. .. .. | 56 | 57 | 57 | 58 | 60 |
| $\frac{1}{3}Fe(CN)_6$ .. .. | 45 | 52 | 58 | 61 | 64 |
| Br .. .. .. | 52 | 53 | 55 | 56 | 57 |
| $\frac{1}{4}Fe(CN)_6$ .. .. | 35 | 43 | 50 | 52 | 65 |
| $\frac{1}{3}AsO_4$ .. .. | 41 | 49 | 55 | 58 | 58 |
| $\frac{1}{2}S_2O_3$ . .. .. | 36 | 44 | 49 | 53 | 58 |
| Cl .. .. .. | 51 | 52 | 52 | 52 | 53 |
| $\frac{1}{2}S_2O_8$ . .. .. | 42 | 49 | 53 | 54 | 55 |
| I .. .. .. .. | 48 | 49 | 50 | 50 | 51 |
| $ClO_4$ .. .. .. | 47 | 48 | 49 | 49 | 50 |
| $NO_3$ .. .. .. | 44 | 48 | 48 | 48 | 49 |
| $\frac{1}{2}SO_4$ .. .. .. | 40 | 42 | 44 | 47 | 50 |
| $\frac{1}{2}CrO_4$ . .. .. | 40 | 41 | 43 | 46 | 48 |
| $\frac{1}{2}SeO_4$ . .. .. | 36 | 39 | 41 | 44 | 47 |
| $MnO_4$ . .. .. | 40 | 41 | 42 | 42 | 43 |
| $ClO_3$ .. .. .. | 38 | 41 | 42 | 42 | 43 |
| $\frac{1}{2}SO_3$ .. .. .. | 34 | 38 | 41 | 42 | 43 |
| $\frac{1}{2}WO_4$ . .. .. | 36 | 38 | 40 | 41 | 44 |
| $\frac{1}{3}PO_4$ .. .. .. | — | — | 34 | 39 | 42 |
| $\frac{1}{2}Cr_2O_7$ .. .. | 34 | 35 | 37 | 37 | 39 |
| $\frac{1}{2}PtCl_6$ . .. .. | 32 | 36 | 38 | 38 | 39 |
| F . .. .. .. | 31 | 32 | 33 | 33 | 34 |
| $\frac{1}{4}P_2O_7$ . .. .. | 20 | 26 | 33 | 40 | 46 |
| $BrO_3$ .. .. .. | 29 | 30 | 31 | 32 | 33 |
| $\frac{1}{2}CO_3$ .. .. .. | 14 | 22 | 29 | 37 | 44 |
| $AsO_2$ .. .. .. | 18 | 18 | 20 | 21 | 24 |
| $IO_3$ .. .. .. | 16 | 17 | 18 | 18 | 20 |
| $\frac{1}{2}B_4O_7$ . .. .. | 13 | 13 | 13 | 13 | 16 |
| $\frac{1}{2}B_2O_4$ . .. .. | 13 | 14 | 14 | 15 | 18 |
| $\frac{1}{2}S_2O_5$ . .. .. | 12 | 12 | 12 | 12 | 12 |
| $\frac{1}{2}SeO_3$ . .. .. | 3 | 10 | 16 | 22 | 31 |

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* It may be as well to point out that the term "atomic conductivities" is rather inappropriate, and might be better replaced by "ionic conductivities."

## THE ESTIMATION OF OPALESCENT SILVER CHLORIDE PRECIPITATES.*

By ROGER CLARK WELLS.

(Concluded from p. 170).

2. *The Excess required to produce Maximum Opalescence.* This point has been frequently discussed. Mulder thought that four times the equivalent of soluble salt was required of the precipitant to ensure complete precipitation from silver chloride solutions. Stas considered a threefold excess sufficient. Several workers have pointed out that the earlier conclusions varied according to the means used to detect the opalescence (Hoitsema, *Zeit. Phys. Chem.*, 1896, xx., 272; Richards and Wells, *Journ. Am. Chem. Soc.*, 1905, xxvii., 483). Without regard to theories, experiments were made upon this point.

KCl (N/0·000040) precipitated by $AgNO_3$.

| | | Intensity of opalescence. |
|---|---|---|
| Excess 5 times equivalent of KCl .. | {31, 29} | 30 |
| " 10 " " .. | {25, 33} | 29 |
| " 100 " " .. | | 24 |
| " 1000 " " .. | | 18 |

Although any excess of silver nitrate up to one hundred times the equivalent of potassium chloride causes no appreciable variation of the opalescence, an excess of one thousand times causes a diminution. This may be due to the great coagulative power of ionised silver, or, more likely, to the formation of a soluble double salt.

$AgNO_3$ (N/0·000040) precipitated by KCl.

| | | Intensity of opalescence. |
|---|---|---|
| Excess 5 times equivalent of $AgNO_3$ | | 23 |
| " 10 " " | {26, 29, 24, 23, 30} | 26 |
| " 50 " " | | 31 |
| " 200 " " | | 32 |
| " 300 " " | | 22 |
| " 1000 " " | {28, 27} | 28 |

The variation of opalescence with excess is here hardly beyond the limit of error of single observations. Certainly a large excess produces no appreciable diminution of opalescence. The two preceding solutions were very concentrated in comparison with real silver chloride solutions, hence more dilute ones were next investigated.

With very dilute solutions, about N/0·000004 and small excesses, a phenomenon like supersaturation was apparent. Excesses of eight times usually failed to produce an opalescence, but excesses of ten times caused a faint opalescence. Here was illustrated the requirement that the solubility product must be exceeded before precipitation can occur. When the solubility product was barely exceeded, opalescence could be made to appear by vigorous stirring. Thus supersaturation does not appear to be limited to soluble salts, and there is no reason to suppose that it should be; but it required rather delicate regulation of the concentrations to render it visible in the case of silver chloride. The influence of the medium was very marked. Only results obtained in proper media are given below, the variations for pure water being enormous; in every case where variation with time was observed the maximum is recorded.

* From the *American Chemical Journal*, xxxv., No. 2.

KCl (N/0·0000040) precipitated by $AgNO_3$.

| | | | | | | Opalescence. |
|---|---|---|---|---|---|---|
| Excess | 25 times equivalent of KCl .. | | | | | 9 |
| " | 75 | " | " | $KNO_3$ | 20 | 24 |
| " | 75 | " | " | $HNO_3$ | 24 | |
| " | 75 | " | " | Both . | 29 | |
| " | 225 | " | " | KCl .. | 25, 33 | 30 |
| " | 450 | " | " | KCl .. | | 24 |

Here the result of too small an excess is very marked. but the diminution caused by a large excess is small, if any,

$AgNO_3$ (N/0·0000040) precipitated by KCl.

| | | | | | Opalescence. |
|---|---|---|---|---|---|
| Excess | 15-fold | $KNO_3$ .. | 50 minutes.. | | 14 |
| " | 25 " | $HNO_3$ .. | 40 " .. | 17 | 20 |
| " | 25 " | $KNO_3$ .. | 50 " .. | 18 | |
| " | 25 " | $HNO_3$ .. | 4 hours .. | 26 | |
| " | 50 " | $KNO_3$ .. | 40 minutes.. | 26 | 24 |
| " | 50 " | $HNO_3$ .. | 40 " .. | 21 | |
| " | 60 " | $HNO_3$ .. | 50 " .. | 26 | 27 |
| " | 60 " | Both .. | 50 " .. | 27 | |
| " | 75 " | Both .. | 3 hours .. | | 31 |
| " | 100 " | $KNO_3$ .. | 40 minutes.. | 20 | 24 |
| " | 100 " | $HNO_3$ .. | 40 " .. | 30 | |
| " | 100 " | $HNO_3$ .. | 2 hours .. | 22 | |
| " | 200 " | $HNO_3$ .. | 10 minutes.. | | 18 |

Notwithstanding the variations which occurred with different media and in the times at which the maxima were observed, a decided regularity is apparent. The maximum opalescence occurs with an excess of about seventy times the equivalent of the ionised silver to be precipitated. If this is more than the theory requires, it is probably due to an overcoming of the tendency towards solubility of the silver chloride in the media employed.

The phenomena for medium concentrations undoubtedly lie between the two extremes of N/0·00004 and N/0·000004 studied.

### 3. *The Time required to obtain Maximum Opalescence.*

The speed of opalescent precipitation is affected by many interrelated variables. For example, it depends upon the excess used, although the influence is not great, providing a proper excess has been used. As one would expect, the greater excess was found to cause a quicker precipitation. Silver nitrate (N/0·000004) was precipitated in two similar solutions containing nitric acid, with opalescence as follows :—

| Time. | Excess 25 times. | Excess 100 times. |
|---|---|---|
| 10 mins. | 18 | 21 |
| 50 | 20 | 22 |
| 540 | 22 | 21 |

The speed is undoubtedly affected by temperature. No experiments were made to illustrate this point, since the tubes which were being compared were usually at the same temperature. The room also remained fairly constant in temperature. This question should receive attention if a method of estimation by standard glasses is perfected, so that corrections could be made for readings taken at different temperatures.

For practical purposes of nephelometry the object is to attain the maximum opalescence in the shortest time possible. The accelerating influence of certain electrolytes had been previously pointed out in a qualitative way (Richards and Wells, *Journ. Am. Chem. Soc.*, 1905, xxvii., 486). It seemed wise, therefore, to study the specific influence of a number of new electrolytes, following the precipitation in a quantitative way by reference to constant glasses. Below are given some of the results so obtained.

$AgNO_3$ (N/0·000040) precipitated by KCl (10-fold excess).

| Time. | Opalescences. Without addition of any salt. | In N/0·025 $KNO_3$ (trace of $HNO_3$). | $KNO_3+HNO_3$. | $HNO_3$. | Trace $HNO_3$. | $Al(NO_3)_3$ (trace $HNO_3$.) | Dilute $H_2SO_4$. | Trace $H_2SO_4$. | $C_2H_4O_2$. |
|---|---|---|---|---|---|---|---|---|---|
| 1 min. | 8 | 25 | 16 | 15 | 11 | 14 | 9 | 8 | 7 |
| 15 " | 9 | 31 | 26 | 30 | 13 | 16 | — | — | 10 |
| 30 " | 10 | 29 | 23 | 29 | 14 | 15 | 28 | 13 | — |
| 80 " | 14 | 28 | 20 | 28 | 14 | 16 | 27 | 19 | 21 |
| 4 hrs. | 20 | 24 | 21 | 26 | 17 | 16 | 26 | 24 | 23 |
| 14 " | 21 | 18 | 18 | 24 | 16 | 16 | 23 | — | 24 |

It will be noticed that the tube containing potassium nitrate attains maximum opalescence in fifteen or twenty minutes. Next in order of speed follow the tubes containing nitric acid, potassium nitrate plus nitric acid, and sulphuric acid. The tube without any electrolyte, except that added to precipitate or that produced by metathesis, was still increasing slowly at the end of fourteen hours. The results were not always so without electrolytes, however, as was shown when considering the medium under the head "Weak Opalescences."

Such readings, extending over many hours, were made with intense, medium, and weak opalescences when precipitated by the addition of silver nitrate to potassium chloride, potassium chloride to silver nitrate, and each of these salts to actual solutions of silver chloride, in the presence of the various electrolytes above mentioned, about four hundred observations in all. The publication of these readings would require many pages. Since many of them turned out to be mere repetitions, it seems wiser to state only the general conclusions.

In general, the substances which aid in producing maximum opalescence also hasten the speed of its formation. Hence the behaviour in water alone was exceptional in every case, except that of the very weakest opalescences. No better accelerators than the "strong electrolytes," salts, and the mineral acids were found. The time of maximum opalescence with good accelerators present varied for the different cases, roughly as follows :—

Intense opalescences (about N/0·00005).

| | Time of maximum. |
|---|---|
| $AgNO_3$ added to KCl .. .. .. | 4 minutes |
| $AgNO_3$ added to AgCl.. .. .. | 20 " |
| KCl added to $AgNO_3$ .. .. .. | 30 " |
| KCl added to AgCl .. .. .. | 20 " |

Medium opalescences (about N/0·00002).

| | |
|---|---|
| $AgNO_3$ added to KCl .. .. .. | 10 minutes |
| $AgNO_3$ added to AgCl.. .. .. | 25 " |
| KCl added to $AgNO_3$ .. .. .. | 25 " |
| KCl added to AgCl .. .. .. | 25 " |

Weak opalescences (about N/0·000005).

| | |
|---|---|
| $AgNO_3$ added to KCl .. .. .. | 20 minutes |
| $AgNO_3$ added to AgCl.. .. .. | 30 " |
| KCl added to $AgNO_3$ .. .. .. | 30 " |
| KCl added to AgCl .. .. .. | 30 " |

In practice it was so difficult to control all but one variable that the results above have a relative rather than an absolute significance. Particularly, too much significance must not be attached to the times, thirty minutes and over, for the opalescence had, in those cases, become so stable that it usually varied only slightly for three or four hours further, and the exact maximum fell now at one time now at another. On this account, if the most exact results are desired, observations should always continue until opalescence begins to fade. Only in this way can one be absolutely certain that the maximum has been attained

That these insignificant variations were due to the state of the water or temperature is rendered probable by the fact that, when the maximum was late in its attainment in one case, it was late in the other tubes that day.

Perhaps the most striking fact in the results is that "actual" silver chloride solutions attain their maximum so much more uniformly than chlorides or silver salts precipitated by the opposite ion. These facts bear upon atomic weight work. In the equal opalescence method, with chloride the time of observation need not be extended beyond an hour, although no error would be introduced by so doing. In determining chloride in a silver chloride solution, however, by nephelometric methods, this point would have to be considered. The proper procedure would be to precipitate the unknown silver chloride solution, allowing it to develop for sixteen minutes, then to precipitate the standard solution, and make the comparison at the end of the next four minutes. The time would be somewhat differently adjusted if silver were being determined. But the use of a glass as a standard of reference would be the best way of all.

A small correction may now be made for this error in determining the atomic weight of sodium. Since the unknown opalescence attained its maximum after the known had begun to fade, too much standard solution was used to match, finally, the unknown opalescence; hence the soluble chloride recorded was too great. The error so committed might have amounted to 20 per cent in the solubility, therefore about 0·002 per cent in a usual determination, hence 0·001 unit in the atomic weight of sodium. The result attained by the gravimetric method, 23·006 (if Ag = 107·93), would become 23·007 with this correction, therefore; but the final average, with the result of the equal opalescence method, 23·009, would still remain 23·008.

It is also now very clear why, in the earlier work with the nephelometer (*Journ. Am. Chem. Soc.*, xxvii., 484), the ratio of two tubes occasionally changed enormously with time, for the standard was increasing in intensity, the unknown solution decreasing. This is shown by the following example. (Many results attained in the earlier work appeared so anomalous that they were never published).

| Time. | Ratio of opalescences. |
|---|---|
| 5 minutes | 3·20 |
| 15 " | 2·76 |
| 30 " | 2·20 |
| 60 " | 1·59 |
| 2·5 hours | 1·19 |
| 7 " | 1·08 |
| 15 " | 0·99 |

It also becomes interesting to speculate as to the causes of the ever-shifting opalescences. It is evident that a given number of small separate visible particles will cause a greater opalescence than the same number collected into an aggregation, for the reflecting surface exposed will be greater. But if it be assumed that some of the single particles are too small to reflect light at all, that would not be true. As the latter assumption is a likely one, the development of opalescence is probably due to aggregation, and precipitation is only the point where the aggregations first attain the limit of visibility. The aggregation may be hastened initially by the presence of electrolytes. The action has been variously explained; Whetham shows agreement between the facts and the theory that a certain number of electrostatic charges must be brought within reach of a colloidal group ("A Treatise on the Theory of Solution," 1902, p. 396). Hence, he assumes that coagulation occurs in consequence of a change in the surface energy of the colloids, due to the presence of the electrostatic charge. Quincke explains the phenomena solely by surface tension changes. It seems reasonable to suppose that aggregation could only be expected to occur rapidly while the particles are small and their kinetic motion or diffusion is rapid. As aggregations become larger the process will become slower, until a point is reached where all aggregations have attained the limit of visibility, and the exposed surface—and therefore the opalescence—begins to decrease, owing to further aggregation. The decrease is less dependent upon the medium than is the initial formation of opalescence. Moreover, a small part of the decrease is due to settling of the particles under the influence of gravity.

The above suppositions are very closely related to the present theories of colloids, and the peculiar behaviour of silver chloride has previously been ascribed to its colloidal condition (Richards and Wells, *Journ. Amer. Chem. Soc.*, xxvii., 484). But Picton and Linder have pointed out that there is probably no difference in kind between a colloid and a crystalloid (*Journ. Chem. Soc.*, 1892, lxi., 148). This is made especially clear by Beckhold in a paper upon the agglutination of bacteria (*Zeit. Phys. Chem.*, 1904, xlviii., 385). He points out that is a continuous transition from crystalloids in the first place to those bodies, partly colloidal, which aggregate in solution so as to produce high molecular weight, then to the real colloids, which look like solutions but are really suspensions, and, finally, to the visible suspensions. Many colloids are coagulated by the addition of univalent, bivalent, and trivalent salts with the relative speeds, 1 : 35 : 1023 (Schulze, *Journ. Prakt. Chem.*, 1882, xxv., 431). The action of aluminium nitrate was tried for the purpose of seeing if silver chloride belongs to this class. Since aluminium nitrate had no unusual effect, two possibilities remained. Either silver chloride is not a colloid, or else it is one which moves with an electric current, and hence, according to Hardy (*Roy. Soc. Proc.*, 1900, lxvi., 110), one would expect only anions to affect its coagulation. Without knowing about its movement in an electric field, coagulation in the presence of sulphates was tried. These also failed to cause unusual speed of coagulation. Hence, there remained only one argument in favour of the colloid theory, the occasional colour of the opalescences. This, however, can be accounted for by strictly physical conceptions. The only tints appearing were a pale blue or a faint reddish brown; now Lord Rayleigh has shown that when the size of reflecting particles approaches the wave-length of light they begin to cease reflecting; but the short blue waves are reflected by particles small enough to transmit the red waves. It seems probable, then, that opalescences occasionally appear blue for the same reason that the sky does—the smallness of the reflecting particles. Similarly, the red tints would be accounted for by transmitted light which has lost its blue component by partial dispersion, though these were not so frequently observed as the blue tints.

It is also interesting to notice that many of the phenomena studied in this paper have a direct bearing upon photography. During the ripening of plates the change of powdery to granular silver chloride takes place. Eder records that unripe emulsions show the red and blue tints by transmitted light (*Photographie*, 1902, ix., 66). According to Liesegang the presence of potassium bromide in developers increases the size of the granules of silver (*loc. cit.*, p. 102), but this is just what would be expected in accordance with the results of the nephelometer.

4. *Proper Treatment for Estimating Various Opalescences*

In order to save the time of those attempting nephelometry, the precautions for several typical cases are here collected:—

*Intense Opalescences* (N/0·00005).

Silver nitrate added to potassium chloride: Add nitric acid or potassium nitrate. Use 8-fold excess. Read in four minutes.

Silver nitrate added to silver chloride, already containing potassium nitrate. Read in twenty minutes.

Potassium chloride added to silver nitrate: Add electrolyte. Use 50-fold excess. Read in thirty minutes.

Potassium chloride added to silver chloride, already containing potassium nitrate. Read in twenty minutes.

*Weak Opalescences* (N/0·000005).

Silver nitrate added to potassium chloride: Add electrolyte. Use 100-fold excess. Read in twenty minutes.

Silver nitrate added to silver chloride, already containing electrolyte. Read in thirty minutes.

Potassium chloride added to silver nitrate: Add electrolyte. Use 70-fold excess. Read in thirty minutes.

Potassium chloride added to silver chloride, already containing electrolyte. Read in thirty minutes.

In general, therefore, the object is to make the standard tubes as nearly like the unknown as possible, or, if standard glasses are being used, to attain the maximum.

The question naturally arises whether the forced maxima are really as uniform as less intense opalescences attained after repose. A considerable weight of confirmatory evidence, which will appear shortly in another paper, shows conclusively that the maxima are the best measures of the concentration. Moreover, electrolytes must be present in some solutions, and uniformity, therefore, demands that they be present in all. It is very likely that occasionally an extreme maximum will be produced, just as too weak opalescence may occur; hence the average of several observations will approach nearer the truth than only one or two.

*Summary.*

1. The chief sources of error in previous nephelometric work are pointed out.
2. The use of ground-glass standards of reference proved advantageous in studying the variation of opalescent precipitates with time.
3. For every concentration a suitable medium and excess of precipitant is required.
4. Electrolytes both augment the maximum opalescence to be precipitated from a solution and hasten its deposition.
5. The bearing of these facts upon other fields is pointed out.
6. Directions for procedure are given for several special cases of nephelometry.

## NOTE ON "THE ESTIMATION OF OPALESCENT SILVER CHLORIDE PRECIPITATES."*

By ROGER CLARK WELLS.

IN the article by me in the February number of the *American Chemical Journal* there was, I regret to state, an incorrect conclusion. In trying to estimate the magnitude of possible error upon the determination of the atomic weight of sodium due to time effects in nephelometry, I based my reasoning upon the behaviour of intense opalescences, whereas, really only weak opalescences were concerned. Prof. Richards, to whom I had, unfortunately, not presented the paper for preliminary reading, immediately called my attention to this, and I am very glad to correct it. It results therefore that the correction, if any, must be even less than 0·001 of a unit in the atomic weight of sodium, and hence quite negligible.

Lest some may attach too much significance to the times of maximum opalescences, I wish to emphasise the fact that the opalescences, especially weak ones, are changing very slowly just before and after their maxima, so that the exact time to a minute means little. Moreover, the variation is occasionally large. The anomalous results illustrating this, referred to in the foot-note (p. 111, *loc. cit.*), were probably due to an insufficient excess of precipitant. Previous work had shown that a long time was often necessary for the opalescences to become relatively stable. My experiments were made to discover the means by which to obtain the maximum opalescence as speedily as possible, and showed that, under the conditions mentioned, on the average, intense opalescences become relatively stable in from one to twenty minutes, medium opalescences in from ten to forty minutes, and weak opalescences in thirty minutes or over.

The maximum was chosen as the best measure of the opalescence, and it could always be found by comparing the opalescence at any time with an unchangeable ground glass. In consequence of the time effects above noted, such a method is more necessary for intense opalescences, which change quickly, than for weak ones which change very slowly. In the case of weak opalescences, the older procedure of waiting a long time before reading, two tubes would yield almost precisely the same result as reading each at its maximum.

In brief, then, as far as time effects in nephelometry are concerned, the time factor must be carefully regulated for intense opalescences, but it ceases to be a major variable with weak ones.—*American Chemical Journal*, xxxv., No. 6.

* See CHEMICAL NEWS, vol. xciv., p. 168 *et seq.*

## NOTE CONCERNING THE USE OF THE NEPHELOMETER.

By THEODORE WILLIAM RICHARDS.

A RECENT article by Dr. R. C. Wells upon "The Estimation of Opalescent Silver Chloride Precipitates" with the help of the nephelometer (*Amer. Chem. Journ.*, 1906, xxxv., 99; CHEMICAL NEWS, xciv. 168 *et seq.*) seems to call for a few additional remarks. The following note is written in order to supplement his suggestions, and to point out clearly the range of applicability of nephelometric methods.

Dr. Wells' conclusions are based upon a series of comparisons in which the cloudiness of a ground glass plate was used as the standard of comparison with the cloudiness produced by opalescent precipitates. This is a good idea, but it is evident that the intensity of light reflected to the eye-piece from this plate will vary with the inclination of the plate to the source of light, and therefore that great care must be taken to have this inclination always definite. Undoubtedly this was taken into account, but the necessity of this precaution was not sufficiently emphasised.

Another cause of uncertainty which, although mentioned as a possible source of error, and also heeded to some extent, may not have been quite sufficiently guarded against in the experimental work, is variation in temperature. Silver chloride is much more soluble in hot than in cold water, and the form of aggregation of the precipitate varies greatly with the temperature. Both these facts cannot but affect the rate of formation of the opalescent precipitate; hence, any work aiming at definite comparison with a fixed standard should be conducted in thermostatted tubes.

Qualitatively, it has been known for many years that the rate of decay of the opalescence, as well as the rate of precipitation, varies greatly with the "concentration" of the precipitate; in other words, with the weight of precipitate suspended in a given volume of liquid. An intense opalescence settles out much more quickly than a faint one. Dr. Wells has quantitatively estimated this difference of behaviour. A saturated solution of silver chloride, such as is usually studied by means of the nephelometer, ordinarily contains not much over 1·5 m.grms. per litre, or is only about 0·00001 N; but two-thirds of the figures given by Dr. Wells refer to solutions as strong as 0·00004 N, nearly four times as concentrated. While it is a matter of great interest to study, as Dr. Wells has done, the rapid rate of deposition of these more concentrated opalescences, they should probably not be made the basis of exact quantitative analytical work, because of their rapid rate of ehange. For quantitative estimation of the substance in such mixtures, it is better not to use the nephelometer, but to collect the precipitate after it has been wholly deposited. The nephelometer should be employed for exact work only

when the precipitate is so finely divided that it will not in any reasonable time, for example, two or three days, deposit itself and thus place itself within the range of ordinary quantitative determination.

It should be strongly emphasised that the "anomalous results" mentioned by Dr. Wells has been duly considered in previous work, and were distinctly pointed out, but the bulk of the previous papers was concerned with indicating the way in which the difficulties can be overcome; therefore but few figures were given.

While the ground glass plate employed by Dr. Wells, when properly and steadily illuminated, undoubtedly affords an excellent means of studying the rate of change in a given mixture, I cannot believe that it provides the best standard of reference for analytical purposes, because it is unaffected by the many variables which affect the mixture to be estimated. In my opinion, if even moderately accurate analytical results are to be had with the nephelometer, the one essential point to be heeded is this:—*The unknown solutions to be estimated must be treated in exactly the same way as the known standard solutions, which serve as the basis of comparison.* If this precaution is adhered to, the changes of temperature, the presence of electrolytes, the concentration of the solutions and all the other variables, affecting each precipitate in like manner, are eliminated from the comparison. This method, indeed, is a fundamental principle in all precise volumetric analysis.

That this precaution was realised in the previous discussion of the instrument may be shown by the following quotation:—

"Care must be taken to have both standard solution and unknown solution subjected to precisely the same conditions, for varying conditions of precipitation may lead to differences in the appearance of the precipitate far greater than the possible optical error of the apparatus. Herein lies the chief caution to be noted in its use.

"The contents of this paper may be summarised as follows:— . . . The chief possibility of error lies in the state of the precipitated material. In order to exclude variation here, the solution to be estimated and the standard solution for comparison should be precipitated in exactly the same way." (Richards and Wells, *Amer. Chem. Journ.*, 1904, xxxi., 242; it should be noted that both these sentences were written by the author, who takes all the responsibility attached to them).

On the same page with these statements is to be found a series of results showing, positively, that when this advice is heeded, and when sufficient time is allowed for the opalescence to develop, the instrument gives reasonably accurate results, and similar evidence is given in another place.

In the course of the work upon the atomic weight of sodium, a singular anomaly was observed, namely, the fact that the opalescence of silver chloride forms more quickly when a solution of this salt is treated with a large excess of silver nitrate than it does when an equivalent solution of sodium chloride is treated in the same way. This irregularity leads to an uncertainty as to whether the *weights* of precipitate corresponding to a given maximum intensity of opalescence are equal in the two cases—an uncertainty clearly pointed out in the place mentioned. The question of weight is not discussed in Dr. Wells' paper, but is now being exhaustively studied at Harvard. The uncertainty arose only because of a slight infringement of the rule italicised above. When the two mixtures are subjected to the same conditions—for example, when both are re-dissolved in ammonia and re-precipitated, the uncertainty disappears. This practice is being adopted in a research on the atomic weight of potassium, now being pursued at Harvard by Dr. A. Stähler, of Berlin, and the author.

In brief, the object of this note may be summarised as follows:—It is pointed out that, while the recent paper of Dr. R. C. Wells on the nephelometer affords interesting data concerning the rate of precipitation of opalescent precipitates, particularly in cases verging upon prompt deposition, it does not emphasise the chief precaution which, in the authors' opinion, should be adopted if the nephelometer is to be used in quantitative analytical work. —*American Chemical Journal*, xxxv., No. 6.

## ON THE COMPOSITION OF PETROLEUM.*

### The Sulphur Compounds and Unsaturated Hydrocarbons in Canadian Petroleum.†

By CHARLES F. MABERY and WILLIAM O. QUAYLE.

In a paper published some time ago by one of us on a preliminary examination of Canadian petroleum (Mabery, *Amer. Chem. Journ.*, 1891, xiii., 89), it was stated that 225 litres of sulphur oil from Canadian burning oil was in process of distillation for the purpose of separating the individual sulphur constituents. On account of the pressure of other lines of work, study of those distillates was delayed, but it has been resumed at intervals until the results described in this paper were obtained.

On returning to this work it seemed worth while to ascertain first whether the oil selected really represented constituents of crude petroleum, or whether it consisted, to a greater or less extent, of decomposition products incident to the process of refining. Since the question of decomposition could be determined in sulphur petroleum from any source, a quantity of crude oil from the Lima, Ohio, field was distilled *in vacuo*, and the distillate, corresponding to that from which burning oil is prepared, carefully separated and agitated thoroughly with alcoholic mercuric chloride, for the purpose of precipitating the sulphur compounds. The oil was next agitated vigorously with ordinary sulphuric acid, the acid sludge drawn off, and diluted with water, carefully avoiding heat so far as possible.

As usual, a dark red oil separated above the solution, but it lacked the heavy sulphurous odour characteristic of sludge as it is ordinarily separated from sulphur petroleum. The odour of this oil resembled that of sludge after the sulphur compounds had been removed, and it showed still greater similarity in its behaviour toward bromine, with which it readily united with the evolution of heat, and the formation of an addition product heavier than water, precisely similar to the behaviour of sludge products. The precipitate with mercuric chloride resembled, in all respects, the characteristic products which are so useful in separating the sulphur compounds.

As further evidence of the presence of unsaturated hydrocarbons in this oil, a portion of the oil precipitated from sulphuric acid was heated with concentrated hydrobromic acid to 100°, and the product fractionated *in vacuo* to collect, in a smaller limit, the bromine addition product. It was not intended to prepare an individual bromine derivative sufficient for analysis, since this would have been impossible with the small amount to be obtained in this manner, but only to be sure that an addition product with hydrobromic acid could be formed. The higher vacuum distillate gave an abundant reaction for bromine after heating with lime, showing that addition of the acid had taken place. The results of these experiments are described in full, that there may be no misapprehension concerning the source of the sulphur compounds and unsaturated hydrocarbons which will be described in this paper. They confirm the results of similar experiments described in the former paper.

In continuing the distillation of the 225 litres of crude sulphur oil, with the aid of the apparatus elsewhere

* Contributions from the Chemical Laboratory of Case School of Applied Science. From the *American Chemical Journal*, xxxv., No. 5

† The sulphur derivatives of the hydrocarbons described in this paper are evidently members of a new series, differing essentially in composition, physical properties, and chemical relations from any of the well-known series of sulphur compounds. For this new series I suggest the name Thiophane.—C. F. M.

described, the distillates were carried through entire up to 250° (50 m.m.) at first within 5°, during four distillations. The lower fractions were then continued within single degree fractions until the lower portions could be distilled under atmospheric pressure. It was not possible to accomplish in this manner more than a general separation, since all the distillates were mixtures, yet the value of the great amount of tedious labour was shown after the separation of the individual constituents, of which the greater portion distilled at approximately the same temperatures as the original distillates; and although it seemed a great expenditure of effort to distil such a large volume of oil in quantities of 10 litres, the capacity of the porcelain still employed, and to continue the distillation of the entire quantity, this seemed to be the only available method for the separation of these peculiar bodies from the crude oil. When first collected, all the fractions were nearly colourless, but on standing they turned dark red, especially those with higher boiling-points. The fractions collected below 125° (50 m.m.) were found to be exceedingly unstable. On standing from six months to two years, some of these distillates deposited very dark, heavy oils, doubtless formed from unstable unsaturated hydrocarbons, terpenes, or sulphur compounds by polymerisation.

In separating the constituents of the vacuum distillates, we followed, in general, the method described in a former paper. 300 or 400 grms. of the oil were shaken in a large flask with an excess of an alcoholic solution of mercuric chloride, which gave a heavy precipitate, crystalline in the lower fractions, a thick viscous mass in the less volatile, and a heavy oily deposit in the vacuum distillates above 160°. There invariably separated above the alcohol a lighter oil, which contained no sulphur, or at most, analysis showed less than 0·5 per cent. Upon diluting the alcohol more lighter oil collected, which doubtless has a different composition from the other, since, as will appear later, it showed essentially different properties.

In recovering the sulphur compounds from the mercuric chloride precipitates, after thoroughly washing with alcohol and very volatile gasolin, the precipitate was decomposed by hydrogen sulphide, in presence of a considerable volume of alcohol, the mercuric sulphide separated by filtration, washed with alcohol, and the alcohol largely diluted. For the most part the lighter oil separated, some remaining in suspension, which collected after standing a short time. With all possible care in washing the mercuric chloride precipitate, a single precipitation was never sufficient to remove all the sulphur-free oil. The percentages of sulphur in the individual sulphur compounds invariably came from 1 to 3 per cent too low, however long they were fractioned, until they were a second time converted into the mercuric chloride compound and again separated by hydrogen sulphide. Upon diluting a second time, usually another portion of the sulphur-free oil collected, or remained in suspension, and, after sufficient fractioning, the percentage of sulphur then corresponded to the value theoretically required.

It has already been explained that the vacuum fractions of the crude sulphur oil, before the separation of its constituents, is a mixture of an unsaturated hydrocarbon, a sulphur compound, and another hydrocarbon of a series not determined. More attention will be given later to the sulphur-free oils. All the portions selected for the separation of these constituents had previously been fractionated from four to twenty times, for the most part *in vacuo*, and since the sulphur oil from any particular fraction has corresponded in boiling-point to that of the fraction before separation, it has been possible to select, from the great number of first fractions, those which should give the bodies desired, thereby saving much time and unnecessary labour in searching for the individual constituents.

After the second precipitation from the mercuric chloride compound, a few distillations *in vacuo*, with the aid of a bead column, in a long-necked flask, have been sufficient to bring together, for the most part within 1° or 2°, the sulphur compound desired. For the separation without decomposition of the sulphur oils boiling above 130°, distillation *in vacuo* has been indispensable. Doubtless exclusion of air, as well as the reduction in boiling-points, especially of the higher members, is essential.

The most volatile vacuum distillates, 40—50°, were subjected to eight additional distillations within limits of 2°, and 300 c.c. of these distillates was agitated with an excess of alcoholic mercuric chloride. A part of the oil was immediately converted into a crystalline precipitate, and the sulphur-free oil, which formed the greater part of the oil taken, remained entirely in solution, and was separated by dilution. After decantation of the alcoholic solution, the crystalline precipitate was well washed with alcohol and light gasolin, and decomposed by hydrogen sulphide in presence of alcohol.

For complete removal of the sulphur-free oil the mercuric chloride compound was again formed, washed, and the sulphur oil separated by hydrogen sulphide. Unfortunately, the larger portion of the sulphur oil was accidentally lost, but the remainder was fractioned, so far as possible, until, finally, it showed a tendency to collect at 125—130°.

The percentage of sulphur found in this product was 27·12; required for the sulphur compound, $C_6H_{12}S$, 27·60°. The crystalline condition of this substance is characteristic of the alkyl sulphides; but all the sulphur bodies we have separated from petroleum are viscous oils that could not be solidified, except the more volatile sulphur compounds such as were separated from Ohio petroleum, which were crystalline.

The following series of sulphur compounds, which have been identified by analysis and shown to have the composition of the general formula $C_nH_{2n}S$, do not represent any series known. They are not members of the ethylene sulphide series, as shown by their reactions and very high specific gravity. In empirical composition they correspond to hydrothiophenes, which have not been synthetically prepared.

### *Heptyl Thiophane.*
(Fraction 158—160°, $C_7H_{14}S$).

The heptyl sulphur compound was identified in the vacuum distillate 71—73° (50 m.m.) seventh distillation. After precipitation with alcohol mercuric chloride, and thorough washing with alcohol and light gasolin, the thick viscous oil was decomposed with hydrogen sulphide, in the presence of alcohol. The oil that separated on dilution of the alcohol was fractionated *in vacuo* until it distilled at 74—76° (50 m.m.) and at 158—160° (750 m.m.). A determination of its sp. gr. at 20° gave 0·8878. Analysis gave percentages of carbon, hydrogen, and sulphur required for the formula $C_7H_{14}S$. Carbon and hydrogen were determined by combustion in lead chromate, the sulphur by combustion in oxygen.

I. 0·1749 grm. oil gave 0·4141 grm. $CO_2$ and 0·1748 grm. $H_2O$.

II. 0·1666 grm. oil gave 0·3071 grm. $BaO_4$.

| | Calculated for $C_7H_{14}S$. | Found. I. | Found. II. |
|---|---|---|---|
| C .. .. | 64·63 | 64·59 | — |
| H .. .. | 10·76 | 11·18 | — |
| S .. .. | 24·61 | — | 25·31 |

### *Octyl Thiophane.*
(Fraction 167—169°, $C_8H_{16}S$).

For the separation of the next sulphur homologue the large quantity of distillate was selected that collected at 79—81° (50 m.m.) after the seventh distillation. 100 c.c., with the treatment described above, yielded 20 c.c. of the sulphur compound that distilled constant at 81—83° (50 m.m.), and at 167—169° under atmospheric pressure. The sp. gr. of this oil was found to be 0·8929 at 20°. Analysis:—

I. 0·1666 grm. oil gave 0·4057 grm. $CO_2$ and 0·1671 grm. $H_2O$.

II. 0·1391 grm. oil gave 0·2282 grm. $BaSO_4$.

| | Calculated for $C_8H_{16}S$. | Found. I. | Found. II. |
|---|---|---|---|
| C .. .. | 66·67 | 66·46 | — |
| H .. .. | 11·11 | 11·22 | — |
| S .. .. | 22·22 | — | 22·53 |

*Isooctyl Thiophane.*
(Fraction 183—185°, $C_8H_{16}S$).

A large amount of distillate collected at 97—99° (50 m.m.), at the end of the seventh distillation, that gave, by analysis, the same empirical formula as the sulphur compound previously described. The term isooctyl is applied to this compound to distinguish it from its isomer. Upon treatment with mercuric chloride and second precipitation, a large amount of sulphur-free oil collected on dilution of the alcohol, and analysis showed that this constituent was completely removed by the second treatment. After fractionating *in vacuo* this product collected to the extent of 15 c.c. at 94—96° (50 m.m.), and distilled with some decomposition at 183—185°, atmospheric pressure. Sp. gr. at 20°, 0·8937. Analyses:—

I. 0·1458 grm. oil gave 0·3592 grm. $CO_2$ and 0·1470 grm. $H_2O$.
II. 0·1561 grm. oil gave 0·3814 grm. $CO_2$ and 0·1575 grm. $H_2O$.
III. 0·2670 grm. oil gave 0·4183 grm. $BaSO_4$.

| | Calculated for $C_8H_{16}S$. | Found. I. | Found. II. | Found. III. |
|---|---|---|---|---|
| C.. .. | 66·67 | 67·19 | 66·16 | — |
| H . .. | 11·11 | 11·27 | 11·29 | — |
| S . .. | 22·22 | — | — | 21·52 |

It will be observed that the last two compounds have the same empirical composition, but differ by 16° or more in boiling-points, and differ also in specific gravity. It will also be observed that they agree closely in boiling-points with butyl and isobutyl sulphides; but they differ widely from the latter in specific gravity:—Butyl sulphide, 0·8523 at 0°; isobutyl sulphide, 0·8363 at 10°; and in other properties.

*Nonyl Thiophane.*
(Fraction 139—195°, $C_9H_{18}S$).

A portion of the distillate that collected in considerable quantity at 106—108° (50 m.m.) was treated in the same manner as previously described, with two precipitations for the separation of the sulphur compound. The product was fractionated *in vacuo* until it collected, for the most part, at 106—108° (50 m.m.). Under atmospheric pressure it boiled at 193—195°, and gave, as its sp. gr. at 20°, 0·8997. Analyses:—

I. 0·1927 grm. oil gave 0·4852 grm. $CO_2$ and 0·2033 grm. $H_2O$.
II. 0·1547 grm. oil gave 0·2210 grm. $BaSO_4$.

| | Calculated for $C_9H_{18}S$. | Found. I. | Found. II. |
|---|---|---|---|
| C .. .. | 68·35 | 68·68 | — |
| H .. .. | 11·40 | 11·80 | — |
| S .. .. | 20·25 | — | 19·62 |

*Decyl Thiophane.*
Fraction 207—209°, $C_{10}H_{20}S$.

From the vacuum distillate, 114—115° (50 m.m.) after the seventh distillation, a sulphur oil was prepared by two precipitations with mercuric chloride that collected, after fractionating some time *in vacuo*, for the most part at 114—116° (50 m.m.). It distilled at 207—209° (750 m.m.) and gave sp. gr., at 20°, 0·9074. Analyses:—

I. 0·2323 grm. oil gave 0·5904 grm. $CO_2$ and 0·2453 grm. $H_2O$.
II. 0·1981 grm. oil gave 0·5078 grm. $CO_2$ and 0·2094 grm. $H_2O$.
III. 0·1654 grm. oil gave 0·2240 grm. $BaSO_4$.
IV. 0·1760 grm. oil gave 0·2407 grm. $BaSO_4$.

| | Calculated for $C_{10}H_{20}S$. | Found. I. | Found. II. | Found. III. | Found. IV. |
|---|---|---|---|---|---|
| C .. .. | 69·77 | 69·33 | 69·92 | — | — |
| H .. .. | 11·62 | 11·32 | 11·82 | — | — |
| S .. .. | 18·60 | — | — | 18·59 | 18·78 |

*Undecyl Thiophane.*
(Fraction 128—130° (50 m.m.), $C_{11}H_{22}S$.

The vacuum distillate, 135—145° (50 m.m.), was selected for the separation of the next homologous sulphur compound. A thick tarry mass was formed by precipitation with mercuric chloride, which gave the pure sulphur oil by a second precipitation. The viscosity of the compounds with mercuric chloride was found to increase with increase in molecular weights of the sulphur oils. 300 grms. of the first distillate, 135—145°, fourth distillation, gave, after the second precipitation with mercuric chloride, 122 grms. insoluble in alcohol, 60 grms. in the alcoholic solution, and 84 grms. of the sulphur oil. Without further purification, the latter gave 16·08 per cent sulphur. After continued fractioning *in vacuo* the sulphur oil collected for the most part at 128—130° (50 m.m.). Analyses:—

I. 0·1793 grm. oil gave 0·4669 grm. $CO_2$ and 0·1896 grm. $H_2O$.
II. 0·2064 grm. oil gave 0·5334 grm. $CO_2$ and 0·2122 grm. $H_2O$.
III. 0·1921 grm. oil gave 0·2411 grm. $BaSO_4$.

| | Calculated for $C_{11}H_{22}S$. | Found. I. | Found. II. | Found. III. |
|---|---|---|---|---|
| C.. .. | 70·98 | 71·01 | 70·71 | — |
| H . .. | 11·82 | 11·82 | 11·50 | — |
| S . .. | 17·20 | — | — | 17·24 |

The sp. gr. of this sulphur oil was found to be 0·9147 at 20°. Particular attention was given to the purification of this product, to be certain of the series as shown by the most careful analysis. In addition to the determinations given above that demonstrate its composition, the following additional analyses were made of different preparations:—Carbon found, 70·73, 70·74; hydrogen in the same combustions, 11·48, 11·95; sulphur, 17·28, 17·05, 17·10.

The portions of the original sludge oil, called sulphur-free oils to distinguish them from the sulphur oils, have contained from 0·1 to 0·3 per cent of sulphur, and it has been assumed that the small proportion of sulphur indicated a little of the sulphur compound not precipitated by mercuric chloride. That the part collecting above the alcohol, after precipitation, is a different product from the part remaining in solution in alcohol is shown by the difference in specific gravity. For example, the distillate 136—145°, from which the oil $C_{11}H_{22}S$ was obtained, gave an oil insoluble in alcohol with sp. gr. 0·8412; but the sp. gr. of the portion in solution was found to be 0·8107. Similar differences appeared in oils associated with other thiophanes. Since the specific gravity of any one of the principal hydrocarbons in Canadian petroleum corresponding in boiling-point with these bodies is smaller than the specific gravity of the sulphur oils, and since hydrocarbons are sparingly soluble in sulphuric acid and alcohol, the bodies under examination cannot be the principal petroleum hydrocarbons. Then the odours of both the substances soluble and insoluble in alcohol are unlike that of any of the hydrocarbons—very pungent, resembling the terpenes. Further study will be necessary to identify these peculiar bodies.

*Quatdecyl Thiophane.*
(Fraction 266—268°, $C_{14}H_{28}S$).

This sulphur oil was separated from the distillate 160—170° (50 m.m.), fourth distillation. After the second precipitation and decomposition by hydrogen sulphide, 400 grms. of the sludge distillate gave 75 c.c. of a yellow oil that collected, for the greater part, at 168—170° (50 m.m.), after extended fractioning. It collected at 266—268°

(750 m.m.) Its sp. gr. at 20° was found to be 0·9208. Analyses :—

I. 0·1859 grm. oil gave 0·5010 grm. $CO_2$ and 0·2109 grm. $H_2O$.

II. 0·2290 grm. oil gave 0·2336 grm. $BaSO_4$.

| | Calculated for $C_{14}H_{28}S$. | Found. I. | Found. II. |
|---|---|---|---|
| C .. .. | 73·68 | 73·52 | — |
| H .. .. | 12·28 | 12·69 | — |
| S .. .. | 14·04 | — | 14·02 |

*Sexdecyl Thiophane.*
(Fraction 283—285°, $C_{16}H_{32}S$).

From 400 c.c. of the first vacuum distillate 170—180° (50 m.m.), after the second precipitation with mercuric chloride and long-continued distillation, 28·5 grms. of the sulphur oil collected at 184—186°, which distilled, with some decomposition, at 283—285° (750 m.m.). Its sp. gr. was found to be 0·9222. Analyses :—

I. 0·2148 grm. oil gave 0·5934 grm. $CO_2$ and 0·2380 grm. $H_2O$.

II. 0·1850 grm. oil gave 0·1683 grm. $BaSO_4$.

| | Calculated for $C_{16}H_{32}S$. | Found. I. | Found. II. |
|---|---|---|---|
| C .. .. | 75·00 | 75·36 | — |
| H .. .. | 12·50 | 12·40 | — |
| S .. .. | 12·50 | — | 12·49 |

To be continued).

## NOTICES OF BOOKS.

*A Text-book of Sanitary and Applied Chemistry.* By E. H. S. Bailey, Ph.D. New York: The Macmillan Company. London: Macmillan and Co., Ltd. 1906.

The chief value of this book lies in the excellent descriptions of experimental work which are given at intervals throughout the text, and which should add greatly to the students' interest in the subject. Although the book is in some respects superficial, and attempts to cover a very wide area, it will at any rate be found stimulating by those who wish to get some idea of the chemistry of daily life, and it gives a very readable account of foods in particular; the notes on economy in the preparation of foods, for example, are thoroughly sensible and practical, and the experiments to illustrate the properties and uses of different classes of food substances are well chosen and clearly described. The chapters devoted to sanitary chemistry deal with the atmosphere, and methods of detecting and removing impurities, fuels, and lighting from the economic point of view, water, sewage and its disposal, and the use of cleaning materials and disfectants. From this enumeration of the contents of the chapters it will be seen that completeness has been the author's aim more than the exhaustive treatment of any one subject, but the book contains a wonderful amount of useful information compressed into a comparatively short volume, and in the hands of a teacher who, basing his lectures upon the experiments in the book, supplements and enlarges, it should be a valuable aid to the teaching of sanitary and applied chemistry.

*Technical Thermometry.* List No. 39, The Cambridge Scientific Instrument Co., Ltd. Cambridge: The University Press. 1906.

List No. 39 of the Cambridge Scientific Instrument Company is far more than a mere catalogue of apparatus, and is well worth the attention of all who are interested in the measurement of temperature. The various appliances are classified according as they are intended more particularly for commercial purposes, or for research and more delicate scientific work. In the first class are included electrical resistance thermometers, which are listed at various prices according to construction and outfit, and thermo-electric thermometers, among which is described a very interesting and novel recording instrument, called a Thread Recorder, which is said to be exceedingly sensitive, and certainly seems from the description to be most simple and convenient. Féry radiation pyrometers are also illustrated in this section, while in the second part the similar but more accurate and delicate measuring instruments, bridges, galvanometers, &c., which are essential if a high degree of accuracy is aimed at, are catalogued. A short appendix which concludes the list deals with theoretical considerations, and contains some tables of general interest.

*Das Erdöl und Seine Verwandten.* ("Petroleum and its Allies"). By Hans Höfer. Second Edition. Braunschweig: Friedrich Vieweg und Sohn. 1906.

The second edition of this book follows the plan of the first, which was one of the earliest of German treatises to treat the subject of petroleum in a thoroughly scientific manner, and the value of which was so universally recognised that it was widely used, and was translated into English. Since its first appearance other books dealing with petroleum, more especially from a geological point of view, have been published, but the great advances which have recently been made in our knowledge make this second edition very welcome. It has been subjected to a careful revision, and much new matter has been added, so that the book has greatly increased in size and correspondingly in value. The statistical information has been brought down to the present day, and the various modern theories put forward as to the origin of petroleum are discussed very fully. As in the earlier edition, the methods of obtaining the oil are treated only very shortly, the chief aim of the author being to provide a thoroughly scientific treatise on the natural history of petroleum and its allies.

## CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxliii., No. 11, September 10, 1906.

**Atomic Weight of Silver.**—Ph. A. Guye and G. Ter. Gazarian.—The authors make a series of researches on the atomic weight of silver, as there has hitherto been some discrepancy in the numbers obtained. Their experiments are chiefly directed towards the determination of the causes of error in the former investigations. They find that the chief error lies in the fact that the chlorate of potash always contains traces of chloride, and the presence of one ten-thousandth of chloride in the $KClO_3$ raises the atomic weight of silver by 0·0177. The mean of the two best applications of the method of the halogenates, corrected and completed as the authors describe, is the number 107·893, or, in round numbers, 107·89. The mean value of ten analyses, all of different silver salts, give as a mean 107·890, and the results are so remarkably concordant that the authors assert that the atomic weight of silver should be lowered from 107·93 to 107·89. This alteration would entail a corresponding correction in a large number of other atomic weights.

## MISCELLANEOUS.

Appointment.—Mr. Geo. Clarke, F.I.C., Head of the Chemical and Agricultural Department, County Technical Laboratories, Chelmsford, has been appointed on the staff of the Indian Agricultural Service by the Secretary of State for India in Council. Mr. Clarke studied at Nottingham University College, 1897-1901, and was afterwards a Demonstrator in the Chemical Department of the School of Technology, Manchester. He succeeded Mr. T. S. Dymond at the Chelmsford Laboratories in 1904.

## MEETINGS FOR THE WEEK.

Wednesday, 17th.—Microscopical, 8. "Some Rotifera of the Sikkim Himalaya," by J. Murray. "*Cornuvia serpula*—a species of Mycetozoa New to Britain," by J. M. Coon.

Thursday, 18th.—Chemical, 8 30. Presentation of Longstaff Medal to Prof. W. N. Hartley. "The Aminodicarboxylic Acid derived from Pinene," by W. A. Tilden and D. F. Blyther. "Preparation and Properties of Dihydropinylamine (Pinocamphylamine)," by W. A. Tilden and F. G. Shepheard. "Determination of Nitrates," by F. S Sinnatt. "Nature of Ammoniacal Copper Solutions," by H. M. Dawson. "Malacone—a Silicate of Zirconium containing Argon and Helium," by S. Kitchen and W. G. Winterson. "Relationship of Colour and Fluorescence to Constitution—Part I., Condensation Products of Mellitic and Pyromellitic Acids with Resorcinol," by O. Silberrad. "Colouring-matters of the Stilbene Group" (Part III.), by A. G. Green and P. F. Crosland. "Separation of α- and ββ-Dimethyladipic Acids" and "Action of Alcoholic Potassium Hydroxide on 3-Bromo-1 : 1-dimethylhexahydrobenzene," by A. W. Crossley and N. Renouf. "Compounds of Pyridine with Dichromates" and "Normal Chromates and the Unsaturated Character of the Chromate Radical," by S. H. C. Briggs. "Interaction of Succinic Acid and Potassium Dichromate—Note on a Black Modification of Chromium Sesquioxide" and "Derivatives of Polyvalent Iodine—The Action of Chlorine on Organic Iodo-derivatives, including the Sulphonium and Tetra-substituted Ammonium Iodides," by E. A. Werner. "New Derivatives of Diphenol (4—4'-Dihydroxydiphenyl)" and "The so-called 'Benzidine Chromate' and Allied Substances," by J. Moir. "Interaction of the Alkyl Sulphates with the Nitrites of the Alkali Metals and Metals of the Alkaline Earths," by P. C. Ray and P. Neogi.


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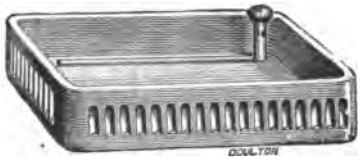

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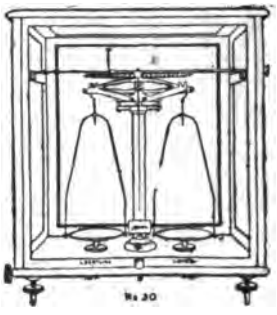

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THE CHEMICAL NEWS.

Vol. XCIV., No. 2447.

## NEW LOW TEMPERATURE PHENOMENA.*

By Prof. Sir JAMES DEWAR, M.A., LL.D., D.Sc., F.R.S.

(Concluded from p. 175).

### *Separation of Highly Concentrated Oxygen from Air by Charcoal at Low Temperatures.*

In order to examine the changes taking place in a mixed gas like air during the absorption, a quantity of about 50 grms. of charcoal was after heating and absorption saturated at $-185°$ in a current of pure dry air—got by passing the air current through a U-tube immersed in liquid air.

For a time the air rushed into the charcoal with great rapidity, and in about ten minutes between 5 and 6 litres were taken in. A manometer attached to the vessel containing the charcoal showed, on shutting off the air current, that during the early part of the saturation the absorption was so effective as to give practically no measurable mercury pressure. As soon as the absorption was ended, and a current began to pass slowly over the charcoal, the composition of the air leaving the charcoal showed 98 per cent nitrogen. After the current of air had passed for half-an-hour, the total gas occluded in the charcoal was expelled by taking the vessel in which it had been treated out of the liquid air, and allowing the temperature to rise to 15° C.

The gas, which was rapidly expelled, measured 5·7 litres, and contained 56 per cent of oxygen. If the saturated charcoal before heating was subjected for an hour to the action of an air-pump, capable of giving a steady exhaustion of 5 m.m., no difference was effected in the oxygen percentage of the evolved gas. The same experiment was repeated with this variation, that, instead of the air current having the pressure of the atmosphere, it was kept below one-tenth of an atmosphere. In this experiment 4·8 litres were expelled on heating up, and the percentage of oxygen was 58. Then a further repetition was made with an air current supplied at a pressure not exceeding 5 m.m. of mercury. After three hours' treatment, the charcoal, on heating to 15° C., gave 4½ litres of 57 per cent oxygen. From these experiments it follows that the tension of the occluded gases, at the temperature of liquid air, must be very small, and thus the use of low temperatures, combined with charcoal, introduces a new and greatly improved means of getting high vacua, which in the future may be found susceptible of important practical applications. These experiments are quite conclusive as to the practical constancy of the mean composition of the air, gases occluded in the charcoal (subject to the conditions aforesaid), and they further show that wide changes in the pressure of the air current has little or no effect in altering the proportions. In another experiment, the vessel containing the saturated charcoal, instead of being allowed to rise rapidly in temperature, was transferred to a vacuum vessel, in which a little liquid air was placed, in order that the temperature might rise slowly, and thereby enable the successive litres of gas given off to be collected separately, and analysed.

This experiment gave the following results:—

| | Oxygen per cent. |
|---|---|
| First litre .. .. .. .. | 18·5 |
| Second ,, .. .. .. .. | 20·6 |
| Third ,, .. .. .. .. | 53·0 |
| Fourth ,, .. .. .. .. | 72·0 |
| Fifth ,, .. .. .. .. | 79·0 |
| Sixth ,, .. .. .. .. | 84·0 |

The mean composition of the 6 litres is again 56 per cent oxygen. From the above experiments it follows that one of the most rapid means of extracting a high percentage of oxygen from atmospheric air is to absorb it in charcoal at low temperatures, and thus to expel it either rapidly or slowly by heating the mass of charcoal to the ordinary temperature.

A few experiments have been made using, instead of air, special mixtures of oxygen and nitrogen. Thus it was found that a gas containing 6·5 per cent of oxygen, used in the same manner as in the air occlusion experiments, gave, on heating up the charcoal rapidly to 15° C., 5 litres of gas having the composition of 23 per cent of oxygen. A repetition of the same process with the 23 per cent of oxygen would have raised the percentage about 60 per cent, or a stronger concentration could have been reached by fractionating the gas as it slowly leaves the charcoal on gradually increasing the temperature.

### *Production of High Vacua and Spectroscopic Studies. Separation of Gases like Helium, Neon, and Hydrogen from Air and other Gas Mixtures (Roy. Soc. Proc., 1904).*

The high absorption of gases by charcoal suggested an inquiry into the limits of gaseous pressure reached by such means of condensation. With this object, an ordinary spectroscopic sparking tube, A B, was sealed to a narrow tube, C E, the end of which was blown into a bulb, D E, capable of containing a few grms. of cocoanut charcoal. After the charcoal had been freed from gases by heating and exhaustion, and the poles cleared by sparking during this operation, pure and dry gases like oxygen, nitrogen, air, carbonic oxide, hydrogen, neon, and helium, could be admitted at different pressures, and the tube with its attached charcoal chamber sealed off.

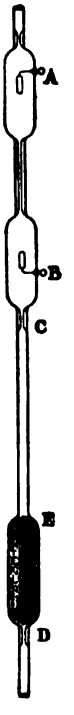



Fig. 2.

On placing the charcoal capsule in liquid air, gas in each case was rapidly absorbed and the vacuum produced reached the phosphorescent stage, except in the cases of hydrogen, neon, and helium.

A large spectroscopic tube of 1300 c.c. capacity was sealed to a bulb containing 30 grms. of charcoal. When the tube was filled with air at atmospheric pressure and the charcoal cooled in liquid air, the pressure fell to 50 m.m. of mercury. On re-filling the tube with air at the pressure of half an atmosphere, and treating it as before, the exhaustion reached beyond the striæ stage, and a final charge at a quarter of an atmosphere gave a vacuum through which no spark passed. When the experiment was repeated with only 1 grm. of charcoal, and an initial pressure of 3 m.m. of mercury, the vacuum just reached the beginning of the phosphorescent stage.

When hydrogen was employed, in order to get a vacuum well up in the striæ stage, either a larger amount of charcoal had to be employed or the initial pressure had to be less than an atmosphere. But if the liquid air-bath was cooled to $-210°$ C. by exhaustion, the tube just reached the beginning of phosphorescence round the cathodes. With helium there was very slight absorption, but more appreciable results were obtained with neon. Spectroscopic observations made during the condensation of the gas in the charcoal showed the gradual disappearance of the characteristic spectrum of oxygen, nitrogen, and air, as the high vacuum was reached, and the discharge passed with great difficulty. In tubes of this kind filled at atmospheric pressure, the F line of hydrogen and the neon yellow could always be seen; but the helium was not seen with any definiteness. As the amount of neon in the air cannot well exceed 1/50,000th, the spectroscopic test is very delicate.

* A Discourse delivered at the Royal Institution, January 20, 1905.

In order to get the helium spectrum the air in the sparking tube had to be enriched six or seven times. This was attained by the apparatus in Fig. 3. AB is the sparking tube, with its small charcoal bulb, C, attached, capable of being sealed off at G when required; and D and E are larger charcoal absorbers placed in vacuum tubes containing liquid air; the whole being attached to a graduated gas-holder, F, containing air. A series of glass stopcocks are attached at the points H, I, J, and K, to facilitate manipulation.

In a preliminary experiment to determine the volume of air necessary to bring in the helium lines, 200 c.c. of air were supplied to one of the charcoal vessels, D, containing 15 grms. of charcoal, from which the residue was passed on to the sparking tube. This tube gave the hydrogen lines C and F, the neon yellow, and some of the orange lines, along with the helium yellow and green quite distinctly. Another tube with the residuary gas from a litre of air gave all the helium lines as well as the neon yellow and the hydrogen F; from which we infer that by this means 1/50,000th of helium can be detected, so that the test is as delicate for helium as for neon. A third tube, supplied from 3 litres of air, gave the neon and helium spectra and a brilliant ruddy glow discharge.

As 40 to 50 grms. of charcoal can absorb at the temperature of liquid air from 5 to 6 litres of air, it is easy to accumulate rapidly the uncondensed gases in considerable quantities for spectroscopic examination. For this purpose it is convenient to use two charcoal condensers in circuit. After the charcoal in the first one, marked E in figure, was saturated, the stopcock, K, was closed, while I and J were opened for a short time to allow the less condensable gas in E to be sucked into the second condenser, D, along with some portion of air. The condenser, E, was then taken out of the liquid air, rapidly heated to 15° C. to expel the excluded air, and was thus ready to repeat the operation. In this way 50 litres of air can be treated in a short time, supplying sparking tubes showing brilliantly the complete spectra of the volatile constituents of the air.

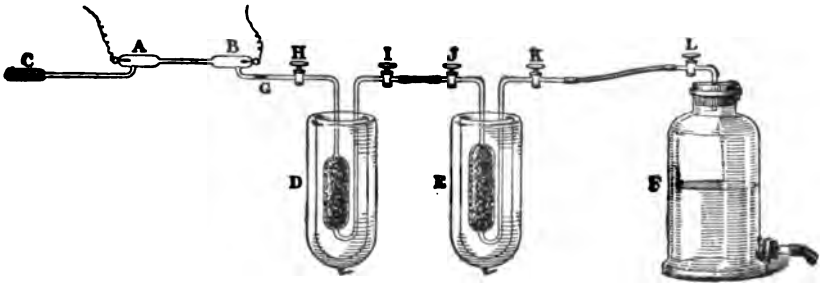



Fig. 3.

The results derived from the treatment of Bath gas in this way are interesting. This gas, consisting mainly of nitrogen and 1/10000th part helium, when subjected to the action of the charcoal condenser in liquid air, gives no high vacuum. All the nitrogen and any other constituents are absorbed, and a spectrum of helium and hydrogen showing much less neon than exists in the volatile residue from atmospheric air is the result. A sample of argon prepared from Bath gas treated in the same way, gives a tube showing the helium and neon spectrum; and one prepared from atmospheric air gives a similar result, but the helium spectrum is the stronger in the Bath argon, whereas with the atmospheric argon the neon spectrum is the most pronounced.

### *Illustrations of various Applications of Charcoal in Experimental Investigations.*

The gaseous products from minerals containing helium, hydrogen, &c., also the products from radium compounds, may be treated by the charcoal method. As an example, I have applied this method to the crude gases got by heating the mineral Fergusonite. During the cooling of the charcoal the nitrogen and hydrogen spectra were marked, but in a short time nothing could be seen but the lines of hydrogen and helium. It is needless to say that the charcoal method of exhaustion can be applied to the manufacture of incandescent lamps and Röntgen radiation tubes, and that the method can be conveniently employed to produce and maintain high vacuum for the purpose of distilling bodies under low pressures. Many experiments with the radiometer can be carried out by the use of the charcoal method of exhaustion. If a charcoal capsule is sealed to the bulb of a radiometer full of air under relatively high pressure, on directing a beam of light on the vanes of the radiometer they remain at rest, showing that the density of the air is too great for motion to take place. When, however, the charcoal capsule is immersed in a vessel containing liquid air, the vanes immediately commence a rapid rotation. On removing this liquid air-bath their motion slackens, and, finally, they come to rest as the charcoal returns to the temperature of the room.

It is known that dry phosphorus does not enter into chemical combination with pure oxygen at ordinary temperature and pressure. A bulb of from 100 to 200 c.c. filled with pure oxygen, having a side tube sealed on of 2 m.m. cross section containing fused phosphorus, the whole being connected by means of a quill tube to a charcoal capsule, containing in part also a good layer of phosphoric anhydride, and the latter immersed in liquid air, the charcoal gradually absorbs the oxygen, and at a particular pressure the oxidation of the phosphorus vapour begins, and is revealed in the form of a phosphorescent glow, filling the whole of the glass bulb, which continues until the oxygen pressure gets too low. On removing the liquid air-bath, at a certain stage of the increasing pressure of oxygen, the bulb again becomes a glowing mass of phosphorescence, which wanes and disappears as the normal pressure is reached. This experiment may be repeated a great many times provided the phosphorus in the small side tube does not get into active combustion, which can always be avoided by a slight cooling. Such bulbs can be kept in the dark for months, and at the end of the time are quite active when cooled as described. A manometer attached to the side of the oxygen bulb shows that the oxygen pressure at the moment phosphorescence begins is only a fraction of a m.m. of mercury. From these results it appears that perfectly dry oxygen below 1 m.m. pressure combines with phosphorus.

The following experiment proving the absorption of carbonic acid, at a small partial pressure, by charcoal is very striking. A continuous stream of ordinary atmospheric air, containing three volumes of carbonic acid in ten thousand, is made to enter the apparatus, Fig. 4, at A and leave at H. It first passes through the jar, B, which contains some strong sulphuric acid, by which it is thoroughly dried. On leaving B the stream of air is divided at C into two portions, one of which passes through the jars D, E,

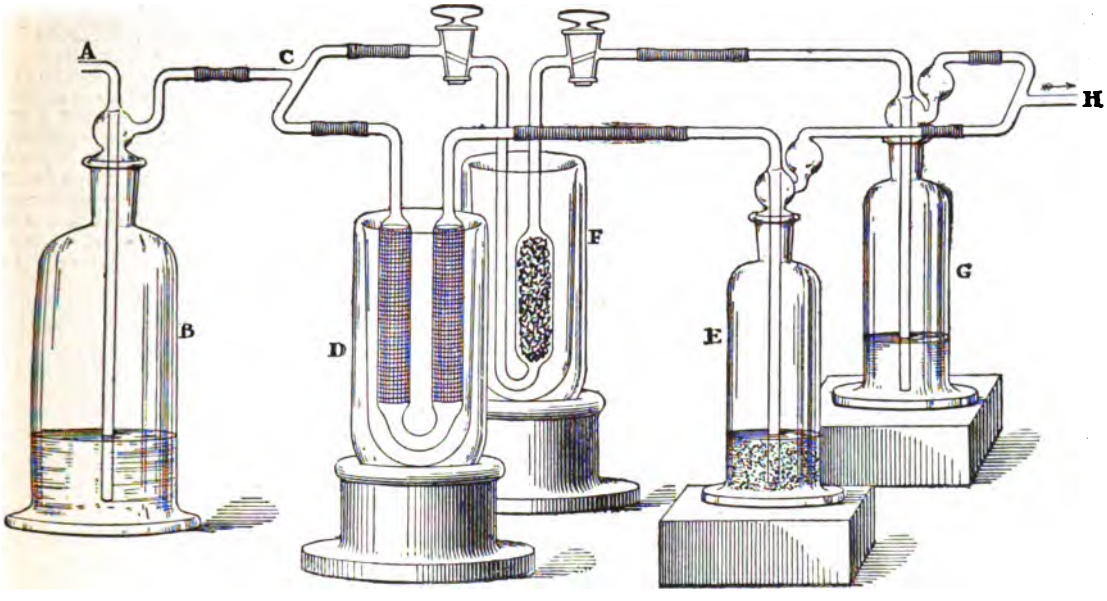



Fig. 4.

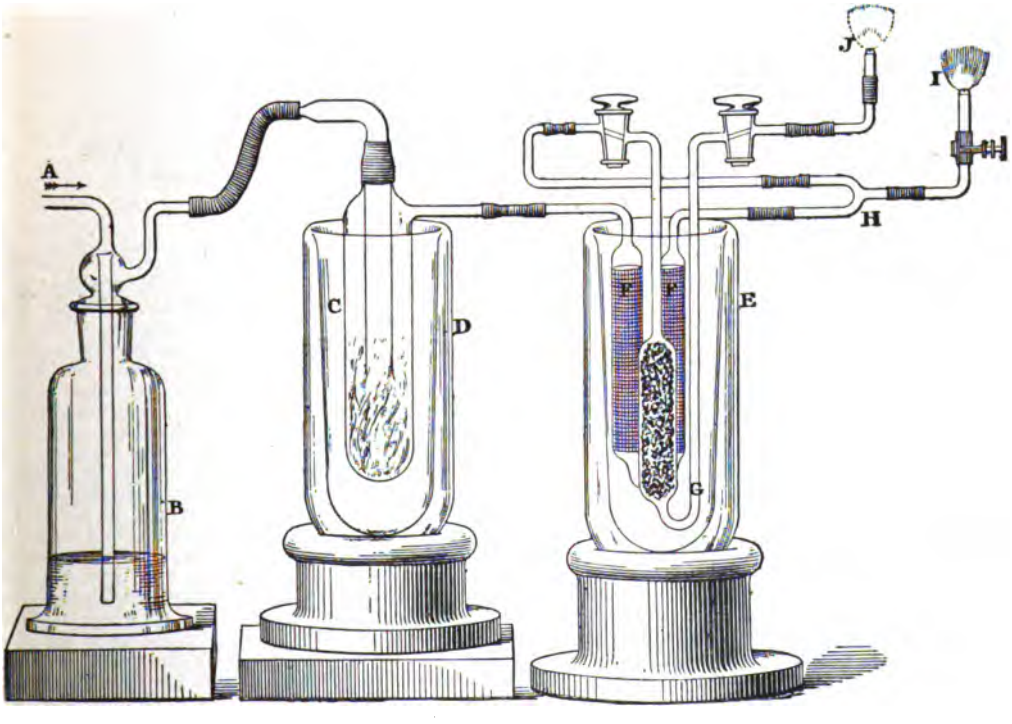



Fig. 5.

the other through the jars F, G, the two finally uniting and passing out at H. D and F are vacuum vessels containing solid carbonic acid, which maintains a temperature of −78° C. The air passes through a U-tube in D, the arms of which are filled with coils of copper gauze to ensure the complete reduction of its temperature to −78° C. It next passes through the jar, E, containing some baryta water, which absorbs the carbonic acid remaining in it, before it emerges at H. The other stream of air passes in like manner through a U-tube in F, in one arm of which is a quantity of dry charcoal in small lumps; thence, after bubbling through some baryta water in the jar, G, it passes

to H, where it escapes. Now, the streams of air entering D and F are in exactly the same state, but while E shows by the milky deposit taking place that the one stream is still fully charged with carbonic acid after being thoroughly cooled to $-78°$ C. in D, G shows by remaining permanently clear that a similar cooling of air to $-78°$ C. in the presence of charcoal causes, for a time, complete absorption of the carbonic acid from the air, and this goes on until the charcoal absorbs about 1 per cent of its weight of carbonic acid.

The absorptive power of charcoal for hydrocarbons is shown in a similar manner by the following experiment:—Common coal-gas enters the apparatus in Fig. 5 by the tube at A, and after being dried by bubbling through strong sulphuric acid in the jar, B, has the less volatile gases condensed by passing through a vessel, C, cooled with carbonic acid snow, isolated in the vacuum vessel, D. The gas is further purified by percolating through the two copper coils contained in the arms of the U-tube, F F, immersed also in solid carbonic acid in the vacuum vessel, E, after which it passes on to H, where its path is bifurcated, one branch leading to I, where the issuing gas is lighted, while by the other branch the purified gas passes over charcoal in the U-tube, G, also at the temperature of solid carbonic acid, before proceeding to J, where it in turn is lighted. The difference between the two flames is very noticeable, that at I being quite luminous, while the other at J is non-luminous, like a Bunsen flame. The explanation is, that the charcoal at the temperature of $-78°$ C. completely absorbs for a time all the hydrocarbons, such as marsh-gas and ethylene, upon which the luminosity of the flame of coal-gas depends, leaving practically carbonic oxide and hydrogen.

This preliminary investigation suggests many fields for further inquiry, and some of these I hope to deal with in future lectures.

My thanks are due to my chief assistant, Mr. Robert Lennox, F.C.S., for valuable aid in the conduct of the experiments; and Mr. J. W. Heath, F.C.S., has also helped in the progress of the work.

## NOTE ON THE ESTIMATION OF HALOGENS IN ORGANIC SUBSTANCES.

By LESLIE HAMILTON BERRY, A.I.C.

The process given below contains no new principle, but its merit lies in the rapidity and ease with which a result can be obtained, and hence commends itself to the notice of practical chemists. It is a combination of Piria and Schiff's heating the substance with lime in two crucibles, and Volhard's thiocyanate titration.

The substance is weighed into a very small platinum crucible, which is then filled up with a mixture of anhydrous sodium carbonate (1 part) and pure powdered quicklime (5 parts). The crucible is then inverted in a larger platinum crucible, the space between the two being filled up with the same mixture of sodium carbonate and lime.

The large crucible is now heated, first with a small blowpipe flame at the bottom of the crucible, and then more strongly heated till the mass is red-hot (duration of heating, one-half hour). The contents are then allowed to cool and dissolved in a large excess of dilute nitric acid (1 acid to 4 water). The substance is added slowly and the acid kept cold. Then add a known excess of N/10 $AgNO_3$ solution, stir vigorously, and heat on water-bath till clear; filter off the silver halide, wash thoroughly, and titrate the filtrate and washings with N/10 KCNS solution, using ammonium ferric alum as an indicator.

When the substance contains iodine, sodium carbonate must be used alone, so as to avoid formation of calcium iodate.

In order to obtain complete decomposition, it was found advisable to take a minimum quantity of the substance.

*Results obtained by this Process.*

Substance used: Chloral Hydrate, $CCl_3CH(OH)_2$; Calculated percentage Chlorine, 64·02.

| | 1. | 2. |
|---|---|---|
| Weight of substance (grm.) .. | 0·1120 | 0·2334 |
| N/10 $AgNO_3$ required (c.c.) .. | 20·25 | 42·20 |
| ≡ Weight chlorine .. .. .. | 0·07188 | 0·14981 |
| Chlorine (per cent) .. .. .. | 64·18 | 64·22 |

Substance used: Dibrombenzene, $C_6H_4Br_2$; Calculated percentage Bromine, 63·56.

| | 1. | 2. |
|---|---|---|
| Weight of substance (grm.) .. | 0·1480 | 0·2133 |
| N/10 $AgNO_3$ required (c.c.) .. | 11·75 | 16·95 |
| ≡ Weight chlorine .. .. .. | 0·0940 | 0·1356 |
| Chlorine (per cent) .. .. .. | 63·51 | 63·55 |

In an estimation with iodoform, $CHI_3$ (calculated percentage iodine, 96·70), 0·3559 grm. required 27·14 c.c. N/10 $AgNO_3$, which gives 96·84 per cent iodine.

The results obtained with dibrombenzene and iodoform are of considerable interest, because they show the applicability of this process to extremely volatile substances.

Technical College, Finsbury.

## DETERMINATION OF MERCURY AND IODINE IN ANTISEPTIC SOAPS.

By ATHERTON SEIDELL.

The germicidal character of the halogen salts of mercury has been recognised for a number of years, and comparative experiments, as quoted by Sternberg ("Text-book of Bacteriology," 1896, p. 188), have shown that the iodide has more then double the antiseptic value of the bichloride. It has been found by Thomson that mercuric iodide can be introduced into soap without forming an insoluble compound with the fatty acids or losing its antiseptic properties. (Thomson, *Journ. Soc. Chem. Ind.*, 1888, vii., 192. The *Journ. Soc. Chem. Ind.* reports the following patents obtained by Thomson:—"An Improved Antiseptic Soap," English Patent No. 9591, July 24, 1886; "Improvements in the Composition of Mercurial Soaps," No. 7117, May 16, 1887. The *Chemische Centralblatt* reports the German Patent, "Preparation of Antiseptic Soaps," D. R. P., No. 49,119, March 22, 1888). The mixture is effected by first dissolving the red iodide in a solution of an alkaline iodide and then incorporating it in the melted soap stock. Samples prepared in this manner were found by experiments upon a number of different organisms to be markedly germicidal in their action. More recent experiments along this line appear to have confirmed the observations of Thomson, and at present there are a number of mercuric iodide soaps on the market. Rideal, in his book upon "Disinfection and the Preservation of Food," 1903, Third Edition, p. 400, states that samples of mercuric iodide soap were found upon analysis to contain 0·37, 0·9, and 3·4 per cent, respectively, of potassium mercuric iodide. Neither the analytical procedure by which these determinations were made nor a reference to it are given by Rideal. Other reference books and a number of journals were examined without success for descriptions of such analyses.

Since no satisfactory method was found by which the mercury and iodine in these soaps could be quantitatively determined, the following investigation was undertaken.

The plan which first suggested itself was to decompose the fatty material by some suitable means and estimate the mercury and iodine in the residue obtained. Among the methods tried and found unsatisfactory for accomplishing this purpose were, first, treatment with fuming nitric acid both at the temperature of the steam-bath and in sealed tubes by the method of Carius; second, digestion in a

Kjeldahl flask with concentrated sulphuric acid; finally, alternate charring and extraction with acid.

The fatty acids could, of course, be removed from the acidified aqueous solution of the soap by filtration or shaking out with ether, but in either case an unavoidable error would result on account of the solubility of mercuric iodide in the fatty bodies, on the one hand ("Solubility of Mercuric Iodide in Fatty Bodies and in some other Solvents," Mèhu, *Journ. Pharm. Chim.*, 1885, [5], xii., 249), and its solubility in the immiscible solvents on the other ("Notice concerning the Solubility of Mercury Haloid Salts especially of Mercuric Iodide in Organic Solvents," Sulc, *Zeit. Anorg. Chem.*, 1900, xxv., 399; "On the Effect of various Solvents on the Allotropic Change of Mercuric Iodide," Kastle and Clarke, *Am. Chem. Journ.*, 1899, xxii., 473).

After considering all these points experiments were made as follows, using a sample of soap prepared in the laboratory by mixing a weighed amount of white toilet soap with a solution of mercuric iodide in potassium iodide:—Portions of this sample were dissolved in warm water, acidified with hydrochloric acid, and, after cooling, an immiscible solvent added to take up the separated fatty acids. Hydrogen sulphide was then passed through the two layers of solution until precipitation appeared complete. The two layers of solution were filtered together, and in some cases separately, but in spite of the greatest care a portion of the fatty material would separate from solution and remain on the sides of the Gooch crucible. Great difficulty was experienced in endeavouring to remove this deposit, and on this account it became necessary to modify the procedure.

After a number of trials it was finally ascertained that advantage could be taken of the solubility of the fatty acids in strong alcohol, to obtain a homogeneous solution of both the organic and inorganic constituents of the sample. The solution is best obtained by adding to the weighed sample of soap contained in an Erlenmeyer flask about 150 c.c. of 95 per cent alcohol, and 3 to 5 c.c. of concentrated hydrochloric acid. The solution is warmed, and successive small portions of water added until a perfectly clear solution is obtained on shaking. If suspended particles of impurities are present, the solution should, of course, be filtered. A slow stream of hydrogen sulphide gas is then passed through the liquid for about an hour, after which time the precipitated mercuric sulphide is filtered on a carefully prepared Gooch crucible. The fatty material present in the solution appears to have a tendency to cause the precipitate to pass through the filter, but no trouble on this account need be experienced, if care is taken to use the least amount of suction possible until the sulphide has been washed several times with 95 per cent alcohol. Although considerable time is required for this filtration, no great delay need be encountered, if a number of determinations are made simultaneously. The weight of mercuric sulphide obtained multiplied by 1·955 gives the amount of mercuric iodide in the weight of sample used.

The filtrate and washings from the mercuric sulphide are transferred to a beaker, and placed on the steam-bath. When the volume of the solution has been reduced to about one-half or one-third of the original volume, water is added to replace the alcohol, the solution cooled, and the separated fats removed by filtration. The clear solution obtained is placed in a glass stoppered separatory funnel together with 25 to 50 c.c. of chloroform. The combined iodine is then liberated by the addition of a few drops of nitrous acid. The iodine thus set free is quickly dissolved by the chloroform on shaking, and by repeating the operation two or three times the whole of the iodine is found in the chloroform solution. This latter is then washed by being shaken several times with distilled water. The washings are treated with fresh chloroform to recover any iodine which may have been taken up by them. Finally, the chloroform solution of the iodine is titrated to loss of colour with standard sodium thiosulphate solution. The number of c.c. required multiplied by the factor for the standard solution gives the grms. of iodine in the sample used.

The nitrous acid solution is prepared by adding to a mixture of about 10 grms. of starch and 10 grms. of arsenious acid contained in a 700 c.c. Erlenmeyer flask about 150 c.c. of nitric acid of 1·3 specific gravity. The solution is warmed gently, and the reddish $NO+NO_2$ fumes conducted by means of a suitably bent glass tube into a bottle containing about 100 c.c. of concentrated sulphuric acid. The solution keeps well, and only a few drops are required at a time to liberate the iodine present in the solution under examination.

*Results of the Determinations of the Mercury and Iodine in Soaps containing Mercuric Iodide.*

| Sample. | Soap taken. | $HgI_2$ added or claimed as present. | $HgI_2$ found. | I (total) found. | I as alkali iodide (calculated). |
|---|---|---|---|---|---|
| | Grms. | Per cent. | Per cent. | Per cent. | Per cent. |
| A .. | 10·0 | 0·83 | 0·92 | 1·00 | 0·48 |
| A .. | 10·0 | 0·83 | 0·72 | 0·94 | 0·54 |
| A .. | 10·0 | 0·83 | 0·85 | 1·18 | 0·71 |
| A .. | 15·0 | 0·83 | 0·96 | 1·07 | 0·54 |
| B .. | 3·14 | 1·0 | 1·13 | 1·63 | 1·00 |
| C .. | 3·69 | 1·0 | 0·70 | 0·97 | 0·58 |
| C .. | 2·87 | 1·0 | 0·78 | 0·90 | 0·46 |
| D .. | 6·39 | 1·0 | 1·21 | 1·39 | 0·72 |
| D .. | 8·38 | 1·0 | 0·94 | 1·30 | 0·78 |
| E .. | 4·33 | 0·1 | 0·11 | 0·17 | 0·11 |
| E .. | 11·80 | 0·1 | 0·10 | 0·22 | 0·16 |
| E .. | 3·15 | 0·1 | 0·10 | 0·12 | 0·06 |

Sample A prepared in the laboratory.
B, C, and D, different samples of the same brand of soap.
Sample E, a purchased preparation.

The method as described above was used for the analysis of several samples of mercuric iodide soap prepared in the laboratory, and purchased samples of soap claimed to contain certain amounts of mercuric iodide. The results obtained are shown in the accompanying table.—*Journal of the American Chemical Society*, xxviii., No. 1.

## A DELICATE COLOUR REACTION FOR COPPER, AND A MICRO-CHEMICAL TEST FOR ZINC.

By HAROLD C. BRADLEY.

It has been known for a number of years that the extract of logwood-hæmatoxylin would produce with copper salts a dark blue colour of some intensity. One of the older and little used differential stains for tissues depended upon this reaction. The microtome section of tissue was immersed first in a copper solution, then washed and immersed again in a dilute solution of hæmatoxylin. Those portions of the tissue which fixed the copper would then be coloured dark blue, while the rest of the tissue remained uncoloured. In this way a stain is produced which will differentiate the cell nucleus from the surrounding cytoplasm. This same reaction was used by Herdman and Boyce ("Report of the Thompson-Bates Laboratories," Liverpool, ii., 1899) to demonstrate copper in the blood and tissues of the oyster, while Mendel and Bradley (*Am. Journ. Phys.*, 1905, xiv., 313) made use of it in localising the copper in the liver tissues of other marine molluscs. So far as we are aware, however, the reaction has never been used as a means of identifying small amounts of copper in solution, nor has it been realised of what extreme delicacy the reaction is susceptible.

Accordingly, a number of trials were made with copper sulphate solutions of varying strengths, to determine within what limits the reaction was available for the detection of copper, and also how the reaction compared in delicacy with other well-known tests for that element. Ferrocyanide,

ammonium sulphide, potassium iodide and starch are the reagents most commonly employed to detect small amounts of copper, and form some of the most delicate reactions of the laboratory. Potassium ferrocyanide gives, with dilute solutions of copper salts, a characteristic brown colour, becoming indistinguishable from the colour of the reagent when the copper solution contains less than 0·001 per cent of the metal. With starch paste and potassium iodide the reaction is slightly more delicate—cuprous iodide and starch iodide of characteristic deep blue being formed—but reaches its limit when the copper solution contains less than 0·001 per cent of the metal. On the other hand, the hæmatoxylin reaction is at its best in just such dilutions, and will serve to recognise copper in solutions of much greater attenuation. The following table shows, roughly, the comparative delicacy of these reactions :—

| Per cent. | Reagent. | | |
|---|---|---|---|
| | Ferrocyanide. | KI+starch. | Hæmatoxylin. |
| 0·01 .. .. | Brown | Blue | Blue |
| 0·001 (Cu) .. | Brown | Blue | Blue |
| 0·0001 .. .. | ? | Blue | Blue |
| 0·00001 .. .. | — | — | Blue |
| 0·000001 .. | — | — | Blue |
| 0·0000001 .. | — | — | Blue |

That is, while under the most favourable conditions ferrocyanide of copper is formed visibly in solutions of one part copper in 100,000 parts of water, blue starch iodide in solutions of one part copper in 1,000,000 parts of water, the copper hæmatoxylin compound is distinctly recognisable in solutions of one part of copper in 1,000,000,000 parts of water. This is, we believe, one of the most delicate reactions known, chemical or physical, and is comparable with the physiological effects of copper salts on certain algæ, with the catalytic effect of copper in certain oxidations, and with the reactions for detecting radio-active bodies of extreme dilution. It is a thousand times more delicate than the ferrocyanide test for copper.

The possibilities for the use of such a reaction as a qualitative test for copper in drinking water from reservoirs treated with copper sulphate to destroy algæ, is at once apparent. Whether the reaction can be applied directly to the proximate analyses of drinking waters, what the conditions for optimum results are, and what the intensely blue copper compound is, are problems still to be worked out.

*Zinc.*—In carrying out some investigations on the normal presence and distribution of zinc in certain marine gastropods (Bradley, *Science*, 1903, xix., 196), the difficulty of recognising definitely small amounts of that metal in tissue ash containing relatively large amounts of copper, iron, calcium, and phosphoric acid, was found to be very great. Zinc forms practically no coloured compounds by which it may be identified in such a mixture, and the ordinary processes of separation are tedious and unsatisfactory. The desirability of finding some rapid and reliable test for zinc led to a thorough canvassing of the less common laboratory reagents for precipitating that metal, and the finding of a microchemical test which proved to be adequate in every way. The reaction is by no means a new one, but its possibilities as a reliable test for zinc seem to have been overlooked.

A moderately concentrated solution of a zinc salt when treated with sodium nitro-prusside throws down a salmon-pink precipitate of zinc nitro-prusside, fairly insoluble in cold water, much less so in hot. The characteristic feature of this precipitate is its definite and readily identified crystal form. All the other insoluble nitro-prussides of the heavy metals are amorphous, slimy precipitates resembling the ferrocyanides in general physical properties. Thus, even in a mixture of several metallic salts, such as copper, silver, cobalt, zinc, &c., the zinc nitro-prusside can be recognised under the microscope by the presence of its characteristic crystals in the amorphous mass of the other nitro-prussides. In performing the test, it is desirable to have the solution of the salts fairly concentrated—about 10 per cent strength is convenient—and to remove the copper by $H_2S$. In such solutions of tissue ash as were used in our experiments, copper was first removed, and the filtrate containing iron, calcium, phosphoric acid, &c., concentrated to small bulk. A drop of this solution placed on a microscope slide and digested with a drop of the freshly prepared nitro-prusside solution, deposited on cooling the rectangular plates and prisms of the zinc salt when that metal was present in such minute amounts that the ordinary methods of separation and identification failed to show it definitely, or required the ashing of large amounts of the original material. For example, by this method zinc was detected readily in the blood of certain molluscs in a few minutes, while by the ordinary methods of separation and analysis—the basic acetate method, or better, the precipitation of the metal as sulphide from a formic acid solution—many hours are required to ash sufficient material and carry through the steps of the analysis.—*American Journal of Science*, xxii., No. 130.

## THE COMBUSTION OF HALOGEN COMPOUNDS IN PRESENCE OF COPPER OXIDE.

By CHARLES J. ROBINSON.

In the course of some work by J. Bishop Tingle and the author of this note, occasion arose for determining carbon and hydrogen in certain compounds containing a halogen, and an attempt was made to do away with the necessity for preparing a combustion tube filled with lead chromate by suitably modifying the ordinary tube containing copper oxide. This purpose was accomplished simply and satisfactorily in the following manner :—

A cartridge, similar to that employed by Morse and Taylor in the analysis of sulphur compounds (*Am. Chem. Journ.*, xxxiii., 602), was made by rolling a small piece of heavy copper wire gauze into the form of a hollow cylinder, which was only 6 or 7 c.m. long, and just fitted into the combustion tube. The cylinder was filled with pure lead chromate, the ends closed by wrapping with copper wire, which also passed lengthwise through the cartridge, and was looped at each end to facilitate removal from the tube. The copper parts were oxidised by ignition. When it was desired to analyse halogen compounds, this cartridge was placed just in front of the boat, in a combustion tube filled in the ordinary way with copper oxide. In burning, care was taken that the part of the tube containing the cartridge was well heated before decomposition of the substance began, but no other special precautions were found necessary. If the space in the tube, or the decomposition temperature of the substance to be analysed demand it, the oxidised spiral in front of the boat should, of course, be removed and the cartridge be allowed to occupy its place.

The advantages gained by the use of this device are that combustions of halogen compounds can be made just as readily as combustions of ordinary compounds, and that the same tube can be used for both. The cartridge may be removed or not, as the operator pleases, to make ordinary analyses subsequent to analyses of substances containing halogens. The same cartridge may be used repeatedly, but no statement can be made as to the number of times it can be employed safely without renewal, because of the great variation in content of halogen in different compounds. The life of the tube itself is not affected as it is when the tube is entirely filled with lead chromate.

The method has been found to be so completely satisfactory that it is judged decidedly preferable, in very many cases, to determine carbon and hydrogen rather than halogen for the identification of new compounds. The time required for the analysis is much shorter, and the figures for the content of carbon and hydrogen in complex

bodies are usually much more distinctive than those for the content of halogen.

No special experiments have been conducted to test the method, but the analyses given below were made in the course of the investigation referred to. The substances analysed are products of the action of *p*-bromphenylhydrazine on camphoroxalic acid. Only the one determination of carbon and hydrogen was made in each case.

I. A compound, $C_{18}H_{23}O_4N_2Br$, melting at 149° with decomposition.

0·2409 grm. substance gave 0·4603 grm. $CO_2$ and 0·1150 grm. $H_2O$.

| | Calculated. | Found. |
|---|---|---|
| C .. .. .. | 52·53 | 52·14 |
| H .. .. .. | 5·63 | 5·34 |

II. A compound, $C_{18}H_{21}O_3N_2Br$, melting at 172° with decomposition.

0·2135 grm. substance gave 0·4308 grm. $CO_2$ and 0·0982 grm. $H_2O$.

| | Calculated. | Found. |
|---|---|---|
| C .. .. .. | 54·94 | 55·03 |
| H .. .. .. | 5·38 | 5·15 |

III. A compound, $C_{20}H_{23}O_2N_2Br$, m. p. 107°.

0·2125 grm. substance gave 0·4624 grm. $CO_2$ and 0·1045 grm. $H_2O$.

| | Calculated. | Found. |
|---|---|---|
| C .. .. .. | 59·52 | 59·35 |
| H .. .. .. | 5·75 | 5·50 |

IV. A compound, $C_{18}H_{19}O_2N_2Br$, melting at 215° with decomposition.

0·1937 grm. substance gave 0·4095 grm. $CO_2$ and 0·0923 grm. $H_2O$.

| | Calculated. | Found. |
|---|---|---|
| C .. .. .. | 57·58 | 57·66 |
| H .. .. .. | 5·10 | 5·33 |

The method has also been applied to the determination of nitrogen in halogen compounds. The cartridge of lead chromate is placed just in front of the substance to be burned, and the latter is mixed with lead chromate, Otherwise the tube is filled in the ordinary way with copper oxide. The results obtained are shown in the following analysis:—

I. The compound $C_{18}H_{21}O_3N_2Br$.

0·2624 grm. substance gave 16·2 c.c. $N_2$ at 19° and 758 m.m.

| | Calculated. | Found. |
|---|---|---|
| N .. .. .. | 7·14 | 7·08 |

The determination of carbon and hydrogen in sulphur compounds could, doubtless, be accomplished in the same manner, in the presence of copper oxide, but no experiments have been made in this direction.—*American Chemical Journal*, xxxv., No. 6.

## ON THE COMPOSITION OF PETROLEUM.*

### The Sulphur Compounds and Unsaturated Hydrocarbons in Canadian Petroleum.

By CHARLES F. MABERY and WILLIAM O. QUAYLE.

(Continued from p. 183).

### *Octodecyl Thiophane.*

(Fraction 290—295°, $C_{18}H_{36}S$).

From 350 grms. of the vacuum distillate 191—210° (50 m.m.), alcoholic mercuric chloride gave a very thick viscous precipitate, from which was obtained, after the second precipitation, 50 grms. of a dark coloured oil that collected, after continued distillation *in vacuo*, nearly colourless, for the most part at 198—202°. Under atmospheric pressure this oil distilled, with some decomposition, at 290—295°; sp. gr. at 20°, 0·9235. The values obtained by analysis corresponded to the formula $C_{18}H_{36}S$.

I. 0·2005 grm. oil gave 0·5602 grm. $CO_2$ and 0·2214 grm. $H_2O$.
II. 0·1937 grm. oil gave 0·1634 grm. $BaSO_4$.
III. 0·2011 grm. oil gave 0·1636 grm. $BaSO_4$.

| | Calculated for $C_{18}H_{36}S$. | Found. I. | Found. II. | Found. III. |
|---|---|---|---|---|
| C.. .. | 76·06 | 76·22 | — | — |
| H . .. | 12·67 | 12·35 | — | — |
| S . .. | 11·27 | — | 11·57 | 11·18 |

We have made no attempts toward the separation of sulphur compounds with higher molecular weights, but there is no doubt that higher homologues are contained in the less volatile distillates which we have separated from the original oil. It is probable that intermediary members of this series are contained in the distillates examined, and that they might be identified in larger quantities of material.

As has been shown in the method of preparation, the thiophanes combine readily with alcoholic mercuric chloride to form viscous oils. They also form addition products with chlorplatinic acid, which are heavy viscous oils. When heated in a sealed tube with ethyl iodide, addition products are formed, which crystallise in small prisms—$C_nH_{2n}S$, $C_2H_5I$. These addition products form alkaline hydroxides when warmed with silver oxide and water:—

$$\overset{\vee}{I}SC_2H_5 \rightarrow HO\overset{\vee}{S}C_2H_5.$$

Bromine exerts a characteristic action on these sulphut compounds. Immediately when they come in contacr combination follows with almost explosive violence and copious evolution of hydrobromic acid, in equivalent amounts to the bromine added. It is wholly unlike the behaviour of unsaturated hydrocarbons with bromine. Probably part of the bromine combines with the sulphur, but the evolution of hydrobromic acid begins immediately, doubtless due to the ready replacement of the methylene hydrogen atoms.

The thiophanes still further resemble the well-known series of sulphur derivatives in their behaviour toward oxidation. The formation and properties of the sulphones will be described later.

In addition to the analytical data that establish the composition of the thiophanes, we have determined their indices of refraction, and the corresponding molecular refraction verifies the formulæ given by analysis.

### *Indices of Refraction of the Thiophanes.*

Many attempts were made, with different solvents, to determine the molecular weights of the sulphur compounds in Canadian petroleum, but no concordant values could be obtained, even with the same substance and the same solvent.

Better success, however, was reached in ascertaining the indices of refraction, but since the values for sulphur in organic compounds have not been determined with the same certainty as in the case of carbon, hydrogen, and oxygen, some attention was given to verifying this constant.

The index of refraction found by Nasini for ethyl sulphide was 1·44233; for ethyl mercaptan, 1·43055; and for ethyl disulphide, 1·50633.

Assigning the accepted values to carbon and hydrogen, the calculated value for sulphur becomes—for ethyl sulphide, 7·98; for ethyl mercaptan, 7·81; and for ethyl disulphide, 8·03. In determining the value of sulphur in ethyl mercaptan, we found the angle to be 49° 24′, which corresponds to the index 1·4323, and the calculated value for sulphur is 7·89.

Isobutyl sulphide gave us 1·4585 as its index of refraction,

* Contributions from the Chemical Laboratory of Case School of Applied Science. From the *American Chemical Journal*, xxxv., No. 5

calculated from the observed angle 44° 57′; the corresponding molecular refraction is 46·85. Assigning the accepted values to carbon and hydrogen, the difference is the value of sulphur, 7·98, the same as the value calculated from Nasini's index of ethyl sulphide.

The index assigned to thiophen is 1·5268, which gives as its molecular refraction 24·12, leaving a value for sulphur 6·53. Thiophen is assumed to have two sets of double bonds. The petroleum sulphur compounds under consideration, although doubtless possessing a ring structure, apparently do not contain carbon atoms connected by double linkage. We have therefore considered it safe to use the value 7·98 for sulphur, and the following molecular refraction for the petroleum sulphur compounds were calculated on the basis of this value :—

*Heptyl Thiophane.*

The fraction 74—76° (50 m.m.), which proved to contain heptyl thiophane, gave as its index of refraction 1·468, corresponding to the following molecular refraction :—

| | |
|---|---|
| Calculated for $C_7H_{14}S$ . .. .. | 40·15 |
| Found .. .. .. .. .. .. | 40·82 |

*Octyl Thiophane.*

From the fraction 83—85° (50 m.m.) was separated octyl thiophane. Its index of refraction was found to be 1·4860, and its molecular refraction—

| | |
|---|---|
| Calculated for $C_8H_{16}S$ . .. .. | 44·75 |
| Found .. .. .. .. .. .. | 44·91 |

*Nonyl Thiophane.*

Nonyl thiophane was found to be the principal constituent of the fraction 106—108° (50 m.m.). It gave as its index of refraction 1·4746, from which was calculated its molecular refraction :—

| | |
|---|---|
| Calculated for $C_9H_{18}S$ . .. .. | 49·35 |
| Found .. .. .. .. .. .. | 49·50 |

*Decyl Thiophane*, $C_{10}H_{20}S$.

The index of refraction of the distillate 114—116°, from which was separated decyl thiophane, we found to be 1·4766. Its molecular refraction was calculated as follows :—

| | |
|---|---|
| Calculated for $C_{10}H_{20}S$ .. .. | 53·94 |
| Found .. .. .. .. .. .. | 53·60 |

*Undecyl Thiophane.*

Undecyl thiophane was found in the fraction 130—135° (50 m.m.). We found its index of refraction to be 1·480, and its molecular refraction—

| | |
|---|---|
| Calculated for $C_{11}H_{22}S$ .. .. | 58·54 |
| Found .. .. .. .. .. .. | 58·53 |

*Quatdecyl Thiophane*, $C_{14}H_{28}S$.

The fraction 168—170° gave quatdecyl thiophane. Its index of refraction, 1·4892, corresponded to the molecular refraction :—

| | |
|---|---|
| Calculated for $C_{14}H_{28}S$ .. .. | 72·33 |
| Found .. .. .. .. .. .. | 71·61 |

*Sexdecyl Thiophane.*

This sulphur compound was found in the fraction 184—186° (50 m.m.). Its index of refraction proved to be 1·4903, from which its molecular refraction was calculated :—

| | |
|---|---|
| Calculated for $C_{16}H_{32}S$ .. .. | 81·52 |
| Found .. .. .. .. .. .. | 80·44 |

The index of refraction of octodecyl thiophane was found to be 1·4977, but the molecular refraction calculated from this value and its sp. gr. (0·9625 at 20°) gave a value different by four units from the calculated molecular refraction.

*Oxidation Products of the Thiophanes.*

Appreciating the importance of oxidation products in ascertaining the composition of the thiophanes, we have tried very thoroughly the action of oxidation agents—nitric acid, chromic acid, and potassium permanganate. These sulphur compounds absorb oxygen with great readiness, and the reaction must be carefully controlled to prevent ultimate oxidation to sulphuric acid. It was not found possible to limit the oxidation to the formation of the sulphoxide, since the sulphone seems to be the more stable condition. Nitric acid readily oxidises the sulphur with an extremely violent reaction, but apparently also forms nitro-derivatives, since the products contain nitrogen.

Chromic acid oxidises the sulphur readily, with some danger that the reaction proceeds to ultimate oxidation. Potassium permanganate, in either alkaline or acid solution, readily effects the change, with little danger of the formation of sulphuric acid. After careful study of the conditions, it was found that the largest yield of oxidation product was obtained by adding slowly to the oil 1·5 times the calculated weight of permanganate dissolved in thirty times its weight of water, keeping the solution cold. With efficient cooling, the permanganate can be added as rapidly as it is decolorised. After the reaction was complete, the precipitated manganic oxide was filtered and the solution distilled with steam, which carried over any unoxidised sulphur compound, leaving behind the oxidation product. When carefully conducted, the solution shows no sulphuric acid. From the residue of the steam distillation the oxidation product was extracted with ether, and the ether evaporated, leaving a thick heavy oil, which increased in viscosity with increase in molecular weight. In several instances we dissolved the precipitated manganic oxide by saturating with sulphurous oxide and extracted with ether. When the oxidation is complete this is the easier method; but distillation with steam ensures the removal of any decomposition products.

The action of oxidising agents showed a wide difference in deportment between the sulphur compounds from Canadian petroleum and sulphides synthetically prepared. For example, synthetic isoamylsulphide, allowed to stand with concentrated nitric acid, showed vigorous reaction only after several minutes, with evolution of heat. After the reaction ceased, heat was applied and water added. The oxidation product collected above the water and partly dissolved. Only a trace of sulphuric acid was found in the solution. On treating the sulphur compounds from Canadian petroleum in the same manner, the reaction was much more vigorous, with immediate evolution of heat. The product formed a thick oil, heavier than water, and much sulphuric acid was formed, but the oxidised oil contained much sulphur, showing that it consisted in part of an oxidised sulphur compound. This difference in the action of nitric acid is pretty conclusive proof that the sulphur compounds under consideration are not alkyl sulphides, nor, indeed, members of any other well-known series. It is in accordance with the observation that the hydro-ring compounds, the methylenes, are less stable towards reagents than the aromatic or paraffin compounds.

*Hexyl Thiophane Sulphone.*

The presence of hexyl thiophane was indicated in the fraction 125—130° (atmospheric pressure), although it was not separated in a pure form. In attempting to prepare the sulphone, the fraction 55—57° (50 m.m.) was treated, as described above, with potassium permanganate. Oxidation was rapid, even when cooled to 0°. In this instance, after dissolving the manganic oxide in sulphurous acid, the solution was evaporated to dryness and the residue extracted with anhydrous ether. Evaporation of the ether left a thick viscous oil with a sweetish taste and odour, with no reaction for sulphuric acid. While the analytical values obtained indicated that the hexyl compound was contaminated with a higher homologue, it is evident that hexyl thiophane was the principal constituent.

*Analysis.*—C, 49·39; H, 8·47; S, 19·02. Required for $C_6H_{12}SO_2$—C, 48·64; H, 8·11; S, 21·62.

*Heptyl Thiophane Sulphone*, $C_7H_{14}SO_2$.

The oxidation of heptyl thiophane was conducted as described above. After neutralising with sodium carbonate and evaporating to dryness, the residue was extracted with anhydrous ether. No sulphuric acid was formed by the oxidation. Analysis:—

I. 0·1992 grm. substance gave 0·3801 grm. $CO_2$ and 0·1531 grm. $H_2O$.

II. 0·1628 grm. substance gave 0·2279 grm. $BaSO_4$.

| | Calculated for $C_7H_{14}SO_2$. | Found. I. | Found. II. |
|---|---|---|---|
| C .. .. | 51·86 | 52·05 | — |
| H .. .. | 8·64 | 8·59 | — |
| S .. .. | 19·75 | — | 19·23 |

This sulphone formed a very thick heavy oil. Its sp. gr. was found to be 1·1138 at 20°.

*Octyl Thiophane Sulphone*, $C_8H_{16}SO_2$.

Fifty grms. of the fraction 87—89°, identified as octyl thiophane, was oxidised carefully at 0°. After dissolving the manganic oxide and distilling with steam, 36 grms. of a heavy oil separated, with no formation of sulphuric acid. After neutralising with sodium carbonate, evaporating to dryness, and extracting with ether, this oil gave as its sp. gr. at 20° 1·1142. Analysis:—

I. 0·1697 grm. substance gave 0·3385 grm. $CO_2$ and 0·1368 grm. $H_2O$.

II. 0·2038 grm. substance gave 0·2702 grm. $BaSO_4$.

| | Calculated for $C_8H_{16}SO_2$. | Found. I. | Found. II. |
|---|---|---|---|
| C .. .. | 54·55 | 54·41 | — |
| H .. .. | 9·11 | 9·01 | — |
| S .. .. | 18·18 | — | 18·21 |

*Nonyl Thiophane Sulphone*, $C_9H_{18}SO_2$.

For oxidation of the nonyl sulphur compound, the fraction 106—108° (50 m.m.) was selected. In the first half of the oxidation the potassium permanganate was added slowly in a bath of ice and salt. The reaction was completed at ordinary temperatures, and it proceeded much more slowly toward the end. The required amount of permanganate was consumed in four days, and no sulphuric acid was formed. In all these oxidations, doubtless, sulphonic acids were formed to some extent, but their removal was ensured by neutralising with sodium hydroxide and extraction of the evaporated residue with anhydrous ether. The sp. gr. of the nonyl sulphone was found to be 1·1161 at 20°. Analysis:—

I. 0·1867 grm. substance gave 0·3874 grm. $CO_2$ and 0·1509 grm. $H_2O$.

II. 0·1679 grm. substance gave 0·2071 grm. $BaSO_4$.

| | Calculated for $C_9H_{18}SO_2$. | Found. I. | Found. II. |
|---|---|---|---|
| C .. .. | 56·83 | 56·61 | — |
| H .. .. | 9·47 | 9·04 | — |
| S .. .. | 16·84 | — | 16·93 |

*Undecyl Thiophane Sulphone*, $C_{11}H_{22}SO_2$.

We were unable to isolate an oxidation product which corresponded closely in composition to decyl thiophane sulphone from the original fraction, and the amount of the thiophane isolated was not sufficient for oxidation.

Undecyl thiophane sulphone was prepared from the undecyl thiophane separated from the fraction 129—131° (50 m.m.); 7·8 grms. of the thiophane gave 5 grms. of the oxidation product. The heavy oil left after distillation with steam had a pleasant sweetish odour; its sp. gr. was found to be 1·1126 at 20°. Analysis:—

I. 0·1903 grm. substance gave 0·4176 grm. $CO_2$ and 0·1621 grm. $H_2O$.

II. 0·1470 grm. substance gave 0·1579 grm. $BaSO_4$.

| | Calculated for $C_{11}H_{22}SO_2$. | Found. I. | Found. II. |
|---|---|---|---|
| C .. .. | 60·54 | 59·84 | — |
| H .. .. | 10·09 | 9·53 | — |
| S .. .. | 14·68 | — | 14·75 |

*Dodecyl Thiophane Sulphone*, $C_{12}H_{24}SO_2$.

After treating 7 grms. of the distillate 142—144° (50 m.m.) with 9 grms. of potassium permanganate, the proportions found most suitable, there still remained a slight odour of the thiophane, which was completely removed by distillation with steam. The oil that remained after extraction of the steam residue with ether gave as its sp. gr. at 20° 1·1372. Analysis:—

I. 0·1533 grm. substance gave 0·3483 grm. $CO_2$ and 0·1402 grm. $H_2O$.

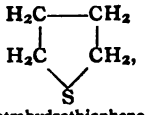
II. 0·1645 grm. substance gave 0·1554 grm. $BaSO_4$.

| | Calculated for $C_{12}H_{24}SO_2$. | Found. I. | Found. II. |
|---|---|---|---|
| C .. .. | 62·07 | 61·98 | — |
| H .. .. | 10·35 | 10·23 | — |
| S .. .. | 13·79 | — | 12·91 |

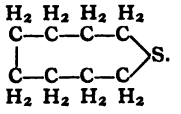
The sulphur compounds in Canadian petroleum have been shown to belong to a series $C_nH_{2n}$. Their structure must be explained either as unsaturated, like the ethylene sulphides, or by a ring arrangement. That these bodies are not of the ethylene series is shown by the facts that the ethylene sulphides are solids, and that they absorb bromine without evolution of hydrobromic acid. The petroleum sulphur compounds have a very high specific gravity, and they evolve hydrobromic acid copiously when treated with bromine. They resemble the well known series of sulphur compounds in forming addition products with mercuric chloride, in the formation of sulphones, the formation of addition products with alkyl iodides, and alkaline hydroxides.

In a former paper by Mabery and Smith it was shown that the sulphur compounds in petroleum are not mercaptans nor thiophens. The series separated by Mabery and Smith from Ohio petroleum formed crystalline addition products with alcoholic mercuric chloride, and the sulphur oils themselves resemble the alkyl sulphides. But the series contained in the portions of Canadian petroleum with higher boiling-points are not alkyl sulphides, mercaptans, thiophens, nor ethylene sulphides. Their high specific gravity shows that they belong to a new series. The cyclic condition of the constituents of Pennsylvania, Ohio, Canadian, Texas, and California petroleum corresponding to the series $C_nH_{2n}$, $C_nH_{2n-2}$, $C_nH_{2n-4}$, &c., has been described in former papers, and the proportions of these series are indicated by the differences in specific gravity. Canadian petroleum is composed for the most part of the series of hydrocarbons poorer in hydrogen. Other constituents of petroleum partake of a similar cyclic condition. The nitrogen compounds, for example, in California petroleum, are tetrahydro and octohydro bodies, with a structure resembling that of the hydroquinolines.

Empirically, the thiophanes are hydrothiophens with long side chains, methylene sulphides with numerous or long side chains, or simple ring methylene sulphides. Either class of formulæ will satisfy the results of analysis. For example:—

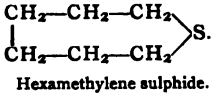


Tetrahydrothiophene or pentamethylene sulphide.

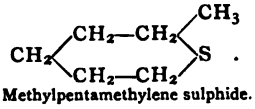


The ready formation of sulphones, addition products with alkyl iodides and hydrates is unlike the thiophens, but the hydrothiothiophens may behave differently. It is improbable that rings with a very large number of carbon atoms can exist. A condensed ring structure like quinoline or naphthoquinoline with sulphur in place of nitrogen, is excluded by the series $C_nH_{2n}$.

As shown above, the lowest member of the series separated from Canadian petroleum was $C_6H_{12}S$, boiling-point 45—50° (50 m.m.), which may be hexamethylene sulphide, or methylpentamethylenesulphide. Higher homologues may reasonably be considered as side chain derivatives :—



Hexamethylene sulphide.



Methylpentamethylene sulphide.

The structure of these bodies will doubtless have to be referred to the methylene ring, yet the precise form of the ring with reference to the number of carbon atoms it contains is still uncertain. For instance, the central group may be a penta-, hexa-, or hepta-methylene ring. It has therefore seemed advisable to employ a comprehensive name that shall include any possible arrangement, and the term thiophane has been adopted. Without doubt, the structure of these sulphur derivatives will be defined with greater precision when the structure of the hydrocarbons of the series $C_nH_{2n}$, $C_nH_{2n-2}$, $C_nH_{2n-4}$, &c., which constitute the greater part of the constituents of petroleum with high boiling-points from any source, are better understood.

To be continued).

## NOTICES OF BOOKS.

*Thirtieth Annual Report of His Majesty's Inspectors of Explosives.* London: Darling and Son, Ltd. 1906.

THE Annual Report for 1905 of His Majesty's Inspectors of Explosives calls attention to the modifications of the law during the year, and describes the results of inspections, giving statistics of the manufacture and storage of explosives, and details regarding their packing, conveyance, &c. It contains the report of the Department's Chemical Adviser, Dr. Dupré, F.R.S., in which is described the research work which is still being continued, and which has apparently not brought to light during the year any facts of great importance. Much space is given to the discussion of accidents caused by explosives and the means adopted to prevent them, while the experiments witnessed by the Inspectors are shortly alluded to, though Dr. Dupré's important investigations with lance composition in connection with an accident at Messrs. Jennison and Co.'s factory are not included, being contained in a special report.

*The Chemical Analysis of Iron.* By ANDREW ALEXANDER BLAIR. Sixth Edition. Philadelphia and London: J. B. Lippincott Company. 1906.

ALTHOUGH this book has perhaps been used more widely in America than in this country, and gives greater prominence to methods generally adopted in the United States, English chemists will no doubt welcome a new edition. All really useful methods are included, and new chapters have been added on chrome-tungsten steels and on ferro-tungsten and tungsten metal, while the importance of the methods of separation and determination of the alloys of the rarer metals, tungsten, chromium, nickel, vanadium, molybdenum, &c., is full recognised, and special attention is paid to them. Many useful suggestions for apparatus will be found worthy of the notice of others besides iron chemists, and the excellent diagrammatic illustrations greatly simplify the instructions for experimeutal work. New and improved methods of determining carbon in iron and steel are given, and the analysis of iron ores, limestone, slags, &c., is discussed, while simple methods of gas analysis are also included.

*The Chemistry of Paints and Paint Vehicles.* By CLARE H. HALL, B.S. London: Archibald Constable and Co., Ltd. 1906.

THERE is undoubtedly room for a short and concise work dealing exclusively with the chemistry of paints, and as such this book will probably be cordially welcomed. In it is given an outline of methods of determining and separating the elementary constituents of paints, for the fuller treatment of which the student would perhaps find it necessary to refer to larger books. Methods of applying strength tests to raw materials are next considered, as well as their properties and estimation, and the analysis of dry colours, pastes, and liquid paints is fully described, both qualitative and quantitative processes being included. The succeeding chapter, on the matching of samples, will be found specially useful and interesting by chemists employed in works for the manufacturing of paints; it contains clear directions for the procedure to be adopted in various cases, while the analysis of oils is also treated very shortly, the author showing considerable judgment in the suggestions for the tests best used by those who are not skilled in oil analysis. The physical characteristics of varnishes and thinners are then briefly described, the quantitative determination of adulterations in turpentine being included.

*Handbuch der Sprengarbeit.* ("Handbook of Blasting"). By OSCAR GUTTMANN. Second Edition. Braunschweig: Friedrich Vieweg und Sohn. 1906.

THE second edition of this well-known text-book, like the first, devotes more attention to practice than theory, and the author has endeavoured to make it specially complete as regards boring machines and blasting materials, which it treats at considerable length. Many new illustrations are included, and the most recent publications have been carefully abstracted, while modern theories are shortly discussed, and a summary is given of those which are to be regarded as important. Blasting operations are described in detail, and the text is arranged systematically, so that the book is an excellent specimen of a convenient work of reference, upon the production of which the author may be congratulated, for the work of collecting and abstracting such a widely scattered literature is a task which calls for no small amount of patience and skill.

## CHEMICAL NOTICES FROM FOREIGN SOURCES.

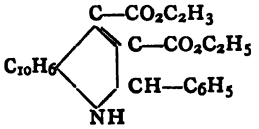
NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxliii., No. 12, September 17, 1906.

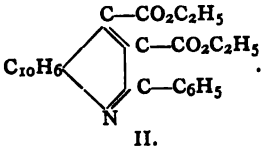
**Action of Fluorine on Chlorine. A New Method of preparing Hypochlorous Acid.**—Paul Debeau.—As a result of a long series of researches, M. Moissan came to the conclusion that, at either ordinary or high temperatures,

fluorine and chlorine have no reaction on one another, either directly or indirectly. The author now investigates the action of fluorine on chlorine at low temperatures, making two series of experiments—one series when working in presence of excess of fluorine, the other in presence of excess of chlorine. He finds that fluorine and chlorine never unite directly. Liquid chlorine dissolves fluorine, but the fluorine is given off again at the solidification-point of chlorine. In presence of water, however, fluorine oxidises chlorine, transforming it completely into hypochlorous acid. This constitutes a new method of preparation of hypochlorous acid: $H_2O+Cl+F = HF+ClOH$.

**Syntheses in the Quinoleic Group. Phenylnaphthoquinoleindicarbonic Acid and its Derivatives.**—L. J. Simon and Ch. Minguin.—The product which predominates during the action of oxalacetic ether on benzylidene-β-naphthylamine is an addition compound, $\begin{array}{l} CO_2C_2H_5—CO—CH—CO_2C_2H_5 \\ \qquad\qquad\qquad\quad | \\ C_{10}H_7—NH—CH—C_6H_5 \end{array}$. When subjected to the condensing action of strong sulphuric acid in the cold, this is transformed into the cyclic compound (I.), after which oxidation by chromic acid regularly transforms it into dicarbonic phenylnaphthoquinoleinic ether (II.).



I.



II.

These results were predicted by L. J. Simon and A. Conduché. After a long investigation the authors now confirm them, and they also find the conditions of saponification of dicarbonic phenylnaphthoquinoleinic ether, and the properties of the resulting acid bodies.

**Action of Mixed Organo-magnesium Compounds on the Imides.**—Constantine Béis.—The author uses mixed compounds of methyl iodide, methyl bromide, ethyl bromide, and phenyl bromide of magnesium, and he finds that only when these compounds are used in a nascent state are satisfactory results obtained, except in the case of methyl iodide, the latter giving a simple molecular addition product. However, in the nascent state he obtains a series of compounds to which the formulæ of isoindolinones are attributed, these being isomers of the phenylamidoketones. The author selects the former because they agree with the results of the preliminary experiments which he makes on the constitution of the bodies. He is continuing his investigations on this subject.

No. 13, September 24.

This number contains no chemical matter.

## MISCELLANEOUS.

**Appointment.**—Dr. H. A. D. Jowett has been appointed manager of the works of Burroughs, Wellcome, and Co., in place of Mr. A. T. Hill, who has resigned.

**New Qualitative Test for Calcium.**—F. F. Flanders.—The difficulty of testing for calcium in the presence of barium and strontium led the writer to turn his attention to a test for this metal which would not be answered by barium and strontium. In this connection the action of potassium ferrocyanide has been tried with surprisingly good results, so good in fact that it seems almost impossible that the reaction has not been used before in this connection. As only one reference could be found to the action of potassium ferrocyanide on calcium compounds (Prescott and Johnson, 1903, p. 212), the fear of repetition is braved and the test described, in the hope that it may prove useful. In separating barium, strontium, and calcium, the commonly accepted method seems to be precipitation with ammonium carbonate in ammoniacal solution, solution of the washed precipitate in acetic acid, removal of barium by potassium chromate or bichromate, re-precipitation of strontium and calcium by ammonium carbonate in ammoniacal solution, re-solution of the precipitate in acetic or hydrochloric acid, removal of strontium by ammonium sulphate, and finally testing for calcium by addition of ammonium oxalate in ammoniacal solution. The weak point in this scheme is the danger of traces of barium and strontium remaining in solution, with the well-known effect on the calcium test. The suggested procedure is the same as the foregoing up to the point of the re-solution of the precipitate after barium has been removed (except that acetic acid only should be used). At this point the solution is divided, and calcium sulphate added to one portion to test for strontium. To the other portion an equal volume of ammonium chloride is added, and a few c.c. of potassium ferrocyanide. The presence of calcium is indicated by the formation of a light yellowish green precipitate. The sensitiveness of the test has been tried on standard solutions of calcium salts, and when applied directly to the calcium solutions was found to indicate 1 part of calcium in 7000 parts. The ammonium oxalate test was also tried, and was found to indicate 1 part in 140,000 parts. The oxalate test was also applied to a series of standard calcium solutions to which strontium had been added. The strontium was removed by ammonium sulphate as in the first method outlined. Under these conditions the addition of ammonium oxalate caused no precipitate in solutions more dilute than 1 part in 14,000. The difference is accounted for by the fact that the ammonium sulphate precipitates out a large amount of calcium with the strontium, and by the fact that calcium oxalate is probably more soluble in ammonium sulphate than in water. The ferrocyanide test was also tried in the regular scheme of analysis, and clearly indicated 1 part in 7000. This 1 part in 7000 seems to be the solubility limit of the calcium-potassium ferrocyanide. Under similar conditions and within the limits of the ferrocyanide test, the volume of the precipitate is about four times as great with ferrocyanide as with oxalate. It might be added that comparatively fresh solutions of potassium ferrocyanide seem to give the best results.—*Journal of the American Chemical Society*, xxviii., No. 10.

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NOTICE IS HEREBY GIVEN that George William Johnson, of 47, Lincoln's Inn Fields, in the County of London, Patent Agent, seeks leave to amend the Specification of Letters Patent No. 22,736 of 1905, granted to him for "Improvements in the Manufacture of Organic Compounds containing Sulphur, and of Red Colouring Matter therefrom."

Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), issued on the 10th October, 1906.

Any person, or persons, may give Notice of Opposition to the Amendment (on Form G), at the Patent Office, 25, Southampton Buildings, London, W.C., within one calendar month from the date of the said Journal.

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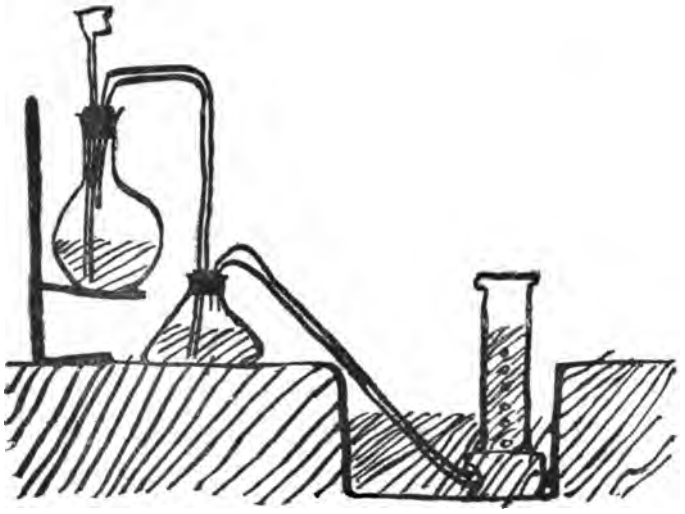

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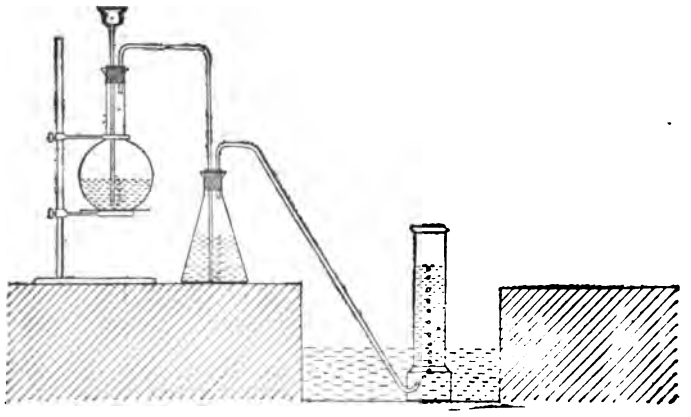

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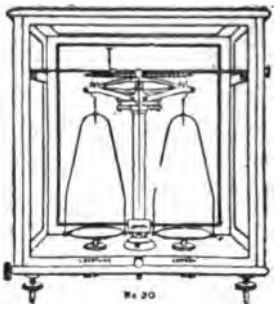

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THE CHEMICAL NEWS.

VOL. XCIV., No. 2448.

## SOME APPLICATIONS OF THE THEORY OF ELECTRIC DISCHARGE TO SPECTROSCOPY.*

By Prof. JOSEPH JOHN THOMSON, M.A., D.Sc., F.R.S., &c., Professor of Natural Philosophy, R.I.

THE luminosity produced by an e'ectric current passing through a gas at low pressure varies greatly in character, not only when we alter the nature of the discharge—as, for example, when we pass from the arc to the spark—but also in many cases at different points of the same discharge. The luminosity may be of one colour at one place and of a very different one at another; a spectroscopic examination shows the spectrum of the same gas often varies considerably as we proceed along the line of discharge. As recent experiments have thrown a considerable amount of light on the processes going on in the different kinds of electrical discharge and at different parts of the same discharge, the study of the connection between the changes in the electrical effects and the changes in the spectra

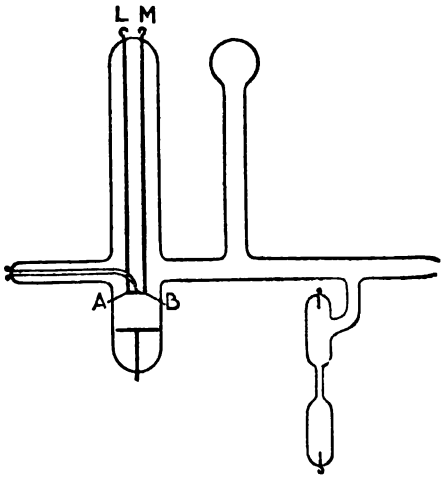


FIG. 1.

might be expected to throw some light on the very interesting question of the genesis of spectra. Many important points can very conveniently be studied by the aid of Wehnelt's method of producing the current. In this method the cathode is a strip of platinum or a piece of platinum-wire on which either a little lime or barium oxide has been deposited. This when heated to redness emits large supplies of corpuscles, and by altering the temperature of the platinum very large variations in the current passing through the tube and the potential difference between the electrodes can be obtained. In our experiments the current has varied from a small fraction of a milliampère to several ampères, and the potential difference from a few volts to several hundred.

The apparatus used is shown in Fig. 1. AB is the platinum strip with the lime on it; a thermo-couple, a platinum and platinum rhodium junction, was fused to this strip, and served to determine its temperature; the strip was connected with the earth, and was heated by a current passing through the leads, LM; a rheostat was placed in series with the heating current, and by means of this the temperature could be altered gradually. The anode was a platinum disc; this was connected with the positive pole of a battery of storage cells, the negative pole of which was earthed; to allow of gradual variations in the potential difference between the electrodes a potential divider of 100 resistances of 10 ohms each was used. The current through the tube was measured by a D'Arsonval galvanometer, and the potential difference between the terminals by a Weston's volt-meter.

Some of the most interesting features of the discharge are very prominent when the temperature of the platinum is high, say, 1400° C., and the pressure of the gas low, less than 0·01 m.m. of mercury. The discharge is light blue, and its spectrum shows the mercury lines and the band spectrum of nitrogen. In this case the relation between the current and the potential difference is represented by a curve like Fig. 2, the ordinates representing the current and the abscissæ the potential difference. G is the point at which the luminosity begins. In the case we are considering, when the wire is very hot and the pressure low, the change from the dark to the luminous discharge takes place very abruptly, an increase of the potential difference by $\frac{1}{100}$th of a volt being often sufficient to convert a dis-

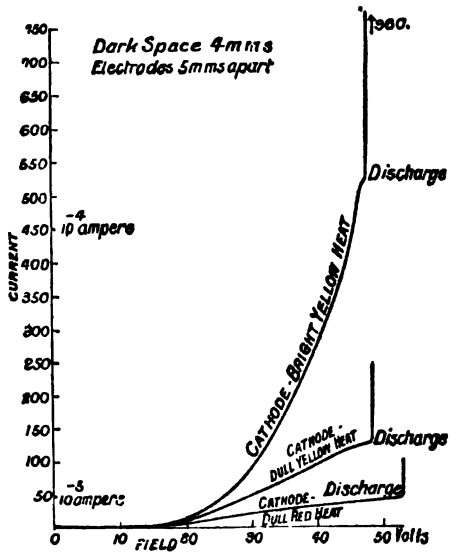


FIG. 2.

charge, where no light could be detected, even in a darkened room, to one where the light was quite bright. When luminosity appears, there is a very rapid increase in the current; in some of the experiments an increase in the potential difference of $\frac{1}{100}$th of a volt increased the current forty-fold. At this stage the thermopile showed that there was no increase in the temperature of the platinum when the luminosity appeared. We shall see later on that it is possible by using large potential differences to get such large currents through the tube that the platinum becomes appreciably warmer by the passage of the current.

One point which I think very suggestive is the abruptness with which the luminosity round the cathode appears. We see that by a very small increase in the potential difference the discharge passes from a state in which no luminosity can be detected, even in a dark room, to one where the luminosity can plainly be seen in a bright light; thus the molecules of the gas in the tube just when the luminous discharge is on the point of appearing, are in a state

* A Discourse delivered at the Royal Institution, January 19, 1906.

in which a very small change in the electrical conditions of the tube make the molecules pass from a state in which they are not giving out an appreciable amount of light to one where they are brightly luminous; and, as the great increase of the current when the luminosity appears shows, this change in state is accompanied by an emission of corpuscles. From this and other considerations, I have come to the conclusion that what takes place when the gas becomes luminous is that the internal energy in the atom in consequence of its bombardment by the corpuscles increases, and when it gets up to a certain critical value the equilibrium of the atom becomes unstable; an explosion occurs, resulting in an expulsion of corpuscles and such a shaking up of those left in the atom that these vibrate so vigorously that the energy radiated is sufficient to produce luminosity. Thus, I regard the ionisation of the gas as being due, not to the corpuscles in the atom being dragged out by the direct action of the electric forces in the field, or as being knocked out by a rapidly moving corpuscle striking against them, but to an explosion due to the atom having absorbed so much internal energy that its equilibrium becomes unstable. Other phenomena point to this as the method by which ionisation is effected. If the corpuscles are dragged out of the atoms by the electric field, the velocity with which they are projected should depend upon the strength of the field; while, if they are projected by an explosion, their velocity would depend upon the nature of the atom and not upon the strength of the field. Now when Röntgen rays fall upon a substance, the atoms of the substance are ionised, and corpuscles, forming a stream of cathodic rays, are emitted. Barkla has lately shown, however, that the penetrating power of the cathodic rays produced in this way is independent of the intensity of the Röntgen rays. Now the electric force in the Röntgen rays depends upon their intensity, and the penetrating power of the cathodic rays depends upon their velocity; so that this result shows that the velocity of the corpuscles does not depend upon the intensity of the force acting upon them. Again, Lenard has shown that the velocity of the corpuscles ejected when ultra-violet light falls upon a metal is independent of the intensity of the light. Lenard also investigated the secondary cathode rays produced when cathode rays fall upon matter, and found that, in addition to rays, whose velocity was of the same order as that of the primary rays, and which may be regarded as deflected primary rays, there were other very slow rays; and the measurements he gives indicate that the velocity of these varies but little with that of the primary rays.

A point of great importance, which can easily be shown by this apparatus, is that the stage at which luminosity sets in depends upon the current density through the tube, and not merely upon the potential difference. One way of showing this is to lower the temperature of the platinum, keeping all the other conditions the same, and again determine the relation between the current and the potential difference. The effect of lowering the temperature is to reduce the number of corpuscles starting from the cathode, so that with the same potential difference the current density is smaller. If the relation between the current and potential difference are represented by curves, such as those in Fig. 3, it will be seen at once that the curve for the cooler electrode cannot be deduced from that for the hotter by reducing all the ordinates in the same proportion. The critical points on the curves, *i.e.*, the place where ionisation by collision begins and where the luminous discharge appears, are at very different potentials; the greater the current density the smaller the potential difference corresponding to these critical points. Thus, to take a case actually observed, when the wire was very hot the discharge was brightly luminous with a potential of 24 volts, but on lowering the temperature no luminosity could be detected with a potential difference of 110 volts.

We can also show the effect of current density without altering the temperature of the cathode, by placing near the tube an electromagnet, so arranged that its lines of magnetic force in the discharge tube are along the line joining the cathode and the anode. The effect of the magnetic field is to make the corpuscles move along the lines of force, and thus, without altering the number of corpuscles emitted by the cathode, it concentrates their paths, and so increases the maximum current density in the tube. When the magnet is on, ionisation by collision and luminosity both occur at a much lower potential difference than when it is off, and it is easy to arrange matters so that keeping the potential difference constant, the discharge is luminous when the magnet is on and dark when it is off. When the potential difference is too small to produce a bright discharge even when the magnet is on, the current through the tube is often greater when the magnet is on than when it is off. By placing the magnet so that the lines of magnetic force are across the line joining the cathode to the anode, we can render the paths of the corpuscles more diffuse than they would be without the field, so that the maximum current density is less when the magnet is on than when it is off. In this case it requires a larger potential difference to produce a luminous discharge

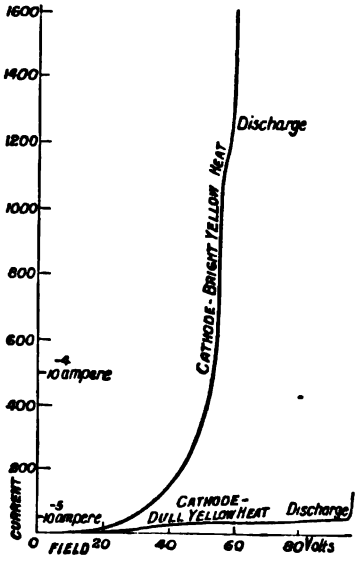


Fig. 3.

with the magnet on than with it off. Similar effects produced by a magnet on another kind of discharge are described in my "Recent Researches," p. 105.

The potential difference, P, just when the glow commences, when the pressure is low, sometimes varies so rapidly with the current $i$ as to be roughly inversely proportional to it. The following are some values of $i$ and P for a gas at a constant low pressure as the temperature of the platinum strip was increased. The numbers are in the order of increasing temperature:—

| $i$ (in scale divisions). | P (volts). | P$i$. |
|---|---|---|
| 6 | 60 | 360 |
| 8·7 | 40 | 346 |
| 11·2 | 30 | 336 |
| 14 | 25 | 350 |

Such a simple relation between P and $i$ is, however, exceptional.

The fact that the potential differences at which ionisation by collision or luminosity begin depend upon the current density, shows that the ionisation or luminosity of an atom need not, and indeed cannot entirely, be the result

of a *single* collision between a corpuscle and the atom. For if that were the case, then, since the energy of the corpuscle depends only upon the electric field and not upon the current density, the effect of increasing the current density would merely be to increase in the same proportion the number of luminous atoms, while, as a matter of fact, if the potential difference is kept constant and the current increased by raising the temperature of the platinum strip, the increase in the luminosity is greater out of all proportion than the increase in the strength of the current.

The result, however, is easily explained if we look at the question from the following point of view:—Suppose that for ionisation or luminosity to take place the internal energy of the atom must increase by certain amounts, say, $E_1$, $E_2$ respectively. Then, if the energy possessed by the corpuscle were very great, the result of one collision with an atom might be to give to the atom enough energy to ionise it or make it luminous, or both. But even if the corpuscle were less energetic, and did not in one collision give enough internal energy to the atom to ionise it, it would communicate some energy to it, and if the atom had any power of storing up energy, this would form a contribution towards the critical amount of energy required by the atom before it is ionised. The atom, after having had this energy communicated to it, would not, as long as it retained any of it, require so much energy to ionise it as before. The atom, too, might acquire energy, not merely by corpuscles striking against itself, but also by the collision of corpuscles with neighbouring atoms. Such collisions generate soft Röntgen rays, the energy of which might be absorbed by the atom under consideration, and help to raise its energy to the critical point. The energy in the Röntgen rays might by itself raise the internal energy of the atom to this value, or else raise it so nearly to this value that the collision with a corpuscle would give it enough energy to carry it past the critical stage. The rate at which the energy, due to collisions of corpuscles with itself or with neighbouring atoms, comes to an atom will be proportional to the rate at which energy is being communicated to the gas, *i.e.*, to $F \times i$, where F is the electric force and $i$ the current density; and thus for a constant electric force would be proportional to the current density. The atom will radiate away some of its internal energy; if the rate of this radiation is proportional to the amount of energy E possessed by the atom, say, equal to $\beta E$, then if $q$ is the rate at which energy is being communicated to the atom, we have—

$$\frac{dE}{dt} = q - \beta E,$$

so, if E vanishes with $t$,—

$$E = \frac{q}{\beta}(1 - e^{-\beta t}).$$

Thus, $q/\beta$ is the limit to the energy acquired by the atom, and this is proportional to $q$, while $q$ is proportional to $Fi$; so that the atom will acquire the critical amount of energy, or not, according as $Fi$ is greater or less than a certain value.

(To be continued).

## THE GERMICIDAL ACTION OF POTASSIUM PERMANGANATE.

(INTRODUCTORY PAPER).

By JAMES B. GARNER and WALTER E. KING.

THE use of solutions of potassium permanganate as a disinfecting agent has been extensive and popular, from the standpoint of both efficiency and economy. Accurate details regarding the antiseptic and germicidal action of potassium permanganate upon *B. typhosus* seem to be lacking. Jäger's and Miquel's statements are only approximate ones (Sternberg's "Bacteriology," p. 186). Jäger says that a 5 per cent solution (approximately N/1·6) of potassium permanganate is a germicide to all pathogenic organisms, excepting tubercle bacillus, and that a 1 per cent solution (approximately N/0·32) is not reliable for the destruction of these same organisms. According to Miquel, potassium permanganate is an antiseptic in the proportion of 1 : 285 (approximately N/0·091).

Our preliminary experiments, made upon a pure 24-hour bouillon culture of *Bacillus typhosus*, with dilute solutions of potassium permanganate, lead us to believe that the reagent is antiseptic and germicidal in less quantities than those given by Miquel and Jäger. The results of these preliminary experiments, therefore, occasioned the work of this introductory paper on the general subject of the germicidal action of potassium permanganate. We purpose to study closely the action of solutions of this reagent upon all of the common pathogenic organisms.

### *Methods.*

In conducting the experiments all apparatus, including pipettes, burettes, test-tubes, flasks, graduates, &c., was sterilised, and all possible precautions were observed to avoid contamination. One-half litre quantities of sterile distilled water, in sterile glass flasks, were used in the eight series. Each series consisted of two flasks of sterile water, to each of which 1 c.c. of a pure 24-hour bouillon culture of *B. typhosus* was added, thus affording a means of checking results. Varying volumes of N/6000, N/4000, N/1000, and N/10 solutions of potassium permanganate were added to the several flasks containing the water and culture. The mixtures were incubated, and, after varying periods of incubation, the ordinary methods were followed to determine the presence or absence of organisms.

### *Experimental Part.*

In each of the two flasks of the eight series given below, 500 c.c. of sterile distilled water were used, varying amounts of potassium permanganate solutions were added, as indicated for the different series, then 1 c.c. of a pure 24-hour bouillon culture of *B. typhosus*, excepting in Series V. The temperature of the incubation was 37·4° and the periods of growth were from twenty-four to seventy-two hours:—

*Series* I.—Flasks *a* and *b*, 25 c.c. N/6000 potassium permanganate were added. Total volume, 526 c.c.

*Series* II.—Flasks *a* and *b*, 20 c.c. N/4000 potassium permanganate were added. Total volume, 521 c.c.

*Series* III.—Flasks *a* and *b*, 20 c.c. N/1000 potassium permanganate were added. Total volume, 521 c.c.

*Series* IV.—Flasks *a* and *b*, 10 c.c. N/10 potassium permanganate were added. Total volume, 511 c.c.

*Series* V.—Flasks *a* and *b*, no potassium permanganate added. *Check flasks.* Total volume, 501 c.c.

*Series* VI.—Flasks *a* and *b*, 25 c.c. N/6000 and 12·6 c.c. N/10 potassium permanganate solutions were added. Total volume, 538·6 c.c.

*Series* VII.—Flasks *a* and *b*, 20 c.c. N/4000 and 20·1 c.c. N/10 potassium permanganate solutions were added. Total volume, 541·1 c.c.

*Series* VIII.—Flasks *a* and *b*, 20 c.c. N/1000 and 50·3 c.c. N/10 potassium permanganate solutions were added. Total volume, 571·3 c.c.

After all the flasks had remained in the incubator for twenty-four hours, tubes of sterile bouillon, 15 c.c. each, were inoculated with 1 c.c. from each flask. These bouillon tubes were incubated for twenty-four hours; cloudy growth was noted in all tubes of Series I., II., III., and V.; slower growth was shown, however, in the tubes inoculated with samples from Series IV., *a* and *b*, and not until the end of thirty-three hours' incubation did these tubes show a uniform cloudy growth. Tubes from Series VI., VII., and VIII. remained clear after forty-eight and seventy-two hours' incubation. Three repetitions of these inoculations gave the same results.

*Tabulation of Results,*

| Series. | Volume of permanganate. C.c. | Total volume. C.c. | Concentration of permanganate. | Growth checked. |
|---|---|---|---|---|
| I., *a* and *b* | 25 N/6000 | 526 | N/126260 | – |
| II., *a* and *b* | 20 N/4000 | 521 | N/104200 | – |
| III., *a* and *b* | 20 N/1000 | 521 | N/26050 | – |
| IV., *a* and *b* | 10 N/10 | 511 | N/511 | (*a*) |
| V., *a* and *b* | None | 501 | | (*b*) |
| VI., *a* and *b* | 25 N/6000<br>12·6 N/10 | 538·6 | N/426·6 | + |
| VII., *a* and *b* | 20 N/4000<br>20·1 N/10 | 541·1 | N/213·35 | + |
| VIII., *a* and *b* | 20 N/1000<br>50·3 N/10 | 571·3 | N/113·06 | + |

(*a*) Growth inhibited, 67 colonies per c.c.
(*b*) Check flasks, 4050 colonies per c.c.

Agar plates were inoculated with 1 c.c. from Flask *a*, Series IV. After forty-eight hours' incubation the average colony count showed 67 per c.c.

An agar plate was inoculated with 1 c.c. from Flask *a*, Series V. After thirty-two hours' incubation 4050 colonies per c.c. were estimated.

In the above experiments all cultures were studied in regard to morphology and cultural characters, and no contaminations were observed.

The results obtained from the flasks of Series IV. indicate that N/511 potassium permanganate is antiseptic to *B. typhosus*.

The mixtures in the flasks resulting from experiments, Series VI. to VIII. inclusive, were of a rose colour, thus indicating an excess of permanganate. An excess of 0·00245 grm. permanganate was found in Flasks *a* and *b* of Series VI., by titration with standard ferrous ammonium sulphate solution in presence of dilute sulphuric acid. This excess, deducted from the total quantity added, left the amount of permanganate which was germicidal to *B. typhosus*. The concentration calculated is N/458.—*American Chemical Journal*, xxxv., No. 2.

## ON THE COMPOSITION OF PETROLEUM.*

### THE SULPHUR COMPOUNDS AND UNSATURATED HYDROCARBONS IN CANADIAN PETROLEUM.

By CHARLES F. MABERY and WILLIAM O. QUAYLE.

(Concluded from p. 194).

*Unsaturated Hydrocarbons of the Series* $C_nH_{2n}$.

THE need of more accurate information concerning the presence of hydrocarbons of the ethylene series, $C_nH_{2n}$, in petroleum, was explained in a former paper of this series. Notwithstanding persistent attempts in the numerous treatises on petroleum to show that these bodies have been identified, a critical examination of published results fails to reveal adequate proof of sufficient foundation for these statements. The statement in "Petroleum and its Products," by Redwood, that De la Rue and Mueller proved the presence, in preponderating quantities, of the ethylene group in Rangoon petroleum is not supported by the results, nor by the conclusions of those authors. Concerning the results of Warren, Schorlemmer, and Chandler, it is not true, as asserted by Redwood, that those chemists found the ethylene series in Pennsylvania petroleum. There are no allusions to this series in Schorlemmer's published papers.

Beyond adopting the general nomenclature then accepted for the ethylene series, Warren evidently left it an open question as to what should be the structural formulæ of the products he separated from Pennsylvania petroleum. There are no statements in his papers to show that he made any further preparation of his products for analysis than boiling with sodium, and no further examination to prove structural forms. Certainly it would have been easy to demonstrate the unsaturated condition of those bodies had they contained doubly bonded carbon, and in view of Warren's clear-sighted and painstaking methods, he could not have overlooked the importance of those tests. In none of his papers on Pennsylvania petroleum does the term olefine or ethylene appear.

The assertion of Hoefer that members of the olefine series, $C_2H_4$ to $C_{30}H_{60}$, have been found in American petroleum, has no foundation. In fact, besides the investigations within recent years in this laboratory leading to a better knowledge of the various series of hydrocarbons with high boiling-points, no attempts have been made to discover the true composition of American petroleum. In fractions below 200° from Galician oil, Lachowicz obtained no reaction with bromine, yet, so far as they have been examined in this laboratory, distillates below 200° from American oils do not fail to show a considerable bromine absorption. The sulphur compounds in Ohio and Canadian oils have a great affinity for bromine. Substitution may take place in the aromatic hydrocarbons which American oils contain, as well as in the hydrocarbons $C_nH_{2n+2}$, unless light is excluded. All these bodies, and probably others, are affected in the ordinary determinations of bromine absorption.

At the suggestion of one of us, (C. F. M.), in connection with another line of work on petroleum, Mr. T. A. Hicks, a student in this laboratory, undertook a study of bromine absorption in crude oil and in fractions obtained from it after various modes of treatment. Two determinations in the oil before treatment gave, as the percentage of bromine absorbed, (I.) 8·43 and (II.) 8·73. A portion agitated with alcoholic mercuric chloride, washed, and dried, gave (I.) 9·27 and and (II.) 9·58, indicating that the crude oil holds in solution, to some extent, the mercuric chloride compound. After treatment with mercuric chloride, a portion of the oil shaken with common concentrated sulphuric acid gave with bromine (I.) 5·91 and (II.) 5·94. The oil was next shaken with fuming sulphuric acid, washed, and dried, when it absorbed bromine equivalent to (I.) 3·47 and (II.) 3·72. A portion of the oil, after the last treatment, was distilled under atmospheric pressure, fractions collected at 100—125°, 125—200°, and 200—230°. In the first distillate the bromine absorption was:—(I.) 4·65, (II.) 4·75; in the second (I.) 4·63, (II.) 4·58; and in the third (I.) 5·61, (II.) 5·17 per cent. Another portion of the treated oil was distilled under 50 m.m., collecting at 130—160°, 160—190°, 190—260°, and a residue, and the bromine absorption determined. Bromine absorption gave in the first distillate (I.) 1·73, (II.) 2·00; in the second (I.) 1·96, (II.) 2·01; in the third (I.) 3·28, (II.) 3·15; and in the residue 9·52. From these results it is evident that substitution in the less volatile portions of the crude oil or cracking has much to do with the amount of bromine absorbed, especially since, in these experiments, the reagents employed for the removal of the sulphur compounds should also remove unsaturated hydrocarbons. In this connection Mr. Hicks determined bromine absorption in some distillates from Pennsylvania, Ohio, and Canadian oils, that has been especially purified by long distillation and treatment with reagents, as has been more fully described in another paper. A distillate, 194—196°, from Pennsylvania petroleum, gave 0·02 per cent bromine absorbed; another, 209—210°, 0·09 per cent; a distillate 209—210° Ohio, purified in the same manner, gave 0·03 per cent bromine, and a Canadian distillate, 0·12 per cent. These results may be accepted as showing no absorption of bromine, since this method is not capable of indicating such small percentages. That the quantity of sulphur remaining in the crude oil, after treating with fuming sulphuric acid, was too small to affect the amount of bromine absorbed, is shown by the low

* Contributions from the Chemical Laboratory of Case School of Applied Science. From the *American Chemical Journal*, xxxv., No. 5.

percentage of sulphur, 0·09, and in the distillate 200—230°, atmospheric pressure, 0·001 per cent.

When the complex composition of American petroleum is borne in mind, and the probability of substitution in the less volatile portions, the difficulties in testing for unsaturated hydrocarbons are evident. Consequently, all discussion of this subject by those best informed has been undertaken with reservation, while those of others partake more of the nature of speculation on results which the authors were content merely with presenting, without attempting explanations which the facts were insufficient to justify.

We have had good evidence that unsaturated hydrocarbons are contained in distillates prepared from crude petroleum. Polymerisation on standing, the formation of dark coloured heavy oils can only be explained by changes in unsaturated hydrocarbons or unsaturated sulphides. Heptylene was described in another paper as a constituent of Ohio oil.

Since the products described in this paper were contained in the oil extracted with sulphuric acid from burning oil distillate, we have assured ourselves, by experiments already described, that ordinary concentrated sulphuric acid, such as is used in refining burning oil distillates, removes from such distillates, without decomposition, the unsaturated hydrocarbons as well as the sulphur compounds, and, consequently, that the sludge oil, after carefully separating from the acid, contained constituents of the crude oil and not products of decomposition.

In fractioning *in vacuo*, as previously explained, a considerable proportion of the distillates from the sludge oil collected below 100°, which could be distilled without decomposition under atmospheric pressure. These portions were therefore carried through ten distillations under atmospheric pressure, and the portions distilling below 150° *in vacuo* also through ten additional separations *in vacuo*. On account of great pressure of other work, these distillates stood three years before their study was resumed, although when first obtained they received sufficient attention to show that they contained unsaturated hydrocarbons (*Am. Chem. Journ.*, xvi., 92).

Upon returning to these distillates, it was found that some of them had undergone a marked change. Those collected at certain temperatures—especially at 44—45°, seventh distillation (50 m.m.); 70—71°, twenty-second distillation (atmospheric pressure); 97—98, tenth distillation (atmospheric pressure); 118—119°, tenth distillation (atmospheric pressure)—corresponding, in part, to the boiling-points of well-known hydrocarbons of the ethylene series, $C_nH_{2n}$, had deposited heavy dark red oils in considerable quantities, evidently products of polymerisation. Some of the polymerised oils were found to contain as much as 8 per cent of sulphur, although polymerisation took place in oils containing not more than 1·5 per cent of sulphur. It was interesting to observe that distillates on either side of those from which the heavy oils separated remained unchanged and were scarcely more discoloured than when they were first distilled. That the distillates below 150° contain sulphur compounds with a peculiar odour, attacking the eyes, and in other respects different from the series $C_nH_{2n}S$ described above, has been apparent since the first distillation of these oils, although these peculiar compounds are evidently present in much smaller proportions than the others.

All these fractions, as well as those above 150°, united with bromine with explosive violence, and with the evolution of great heat. The bromine addition products, however, were found to be so unstable that it was impossible to purify them by distillation even *in vacuo*. They decompose rapidly, even on standing, with the separation of hydrobromic acid. In ascertaining the composition of these hydrocarbons we have therefore relied on the more stable addition product obtained with hydrobromic acid, which had the further advantage that having no action on the sulphur compounds, the latter need not be removed before heating with the acid.

### *Hexylene.*

For the identification of hexylene, the small quantity of the fractions 70—80°, twenty-second distillation (atmospheric pressure), were put together, and a portion was heated to 120°, during five hours, with fuming hydrobromic acid. The product was washed, dried, and fractioned *in vacuo*. On account of the higher boiling-point of the bromide it was easy to separate the addition product, and of the small quantity obtained the greater portion collected at 62—65° (50 m.m.). The boiling-point of the bromide under atmospheric pressure could not be determined on account of its instability, but it probably was not far from 135°. The distillate selected for the formation of this bromide was nearly the same in boiling-point as that of the hexylenes from various sources, 65—70°. Upon analysis values were obtained corresponding to those required for monobromhexane:—

I. 0·1938 grm. oil gave 0·3108 grm. $CO_2$ and 0·128 grm. $H_2O$.

II. 0·2720 grm. oil gave 0·3045 grm. AgBr.

| | Calculated for $C_6H_{13}Br$. | Found. I. | Found. II. |
|---|---|---|---|
| C .. .. | 43·63 | 48·73 | — |
| H .. .. | 7·88 | 7·41 | — |
| Br .. .. | 48·51 | — | 47·64 |

On account of the small amount of this substance it was not possible to purify it more completely.

### *Heptylene.*

The fractions 98—102°, tenth distillation (atmospheric pressure), more nearly corresponding to the boiling-points of the various heptylenes, 90—100°, were selected especially because they contained a considerable quantity of the polymerised oil. On either side of these limits the distillates had not changed. After treatment with fuming hydrobromic acid and fractioning *in vacuo*, the greater portion of the bromide collected at 76—80° (50 m.m.). It could not be distilled under atmospheric pressure, but its boiling-point was probably not far from 160°. The results of analysis corresponded to the composition of monobromheptane:—

I. 0·2000 grm. oil gave 0·3498 grm. $CO_2$ and 0·1592 grm. $H_2O$.

II. 0·2117 grm. oil gave 0·2188 grm. AgBr.

| | Calculated for $C_7H_{15}Br$. | Found. I. | Found. II. |
|---|---|---|---|
| C .. .. | 46·97 | 47·71 | — |
| H .. .. | 8·38 | 8·90 | — |
| Br .. .. | 44·73 | — | 43·99 |

The sp. gr. of this heptyl bromide was found to be 1·1601.

### *Octylene.*

Octylene was sought for in the fraction 118—119°, tenth distillation (atmospheric pressure), from which had separated a small quantity of the heavy polymerised oil. After heating with concentrated hydrobromic acid the oil was fractioned *in vacuo* until 15 grms. collected at 93—95° (50 m.m.), corresponding, approximately, to 180°, atmospheric pressure. The boiling-point of the distillate selected is near that of di-isopropyl ethylene, 116—120°, and also that of the octylene, 115—117°, prepared from octylene chloride by Schorlemmer.

Analyses of the bromide gave values required for monobromoctane:—

I. 0·1941 grm. oil gave 0·3486 grm. $CO_2$ and 0·1613 grm. $H_2O$.

II. 0·1885 grm. oil gave 0·1851 grm. AgBr.

| | Calculated for $C_8H_{17}Br$. | Found. I. | Found. II. |
|---|---|---|---|
| C .. .. | 49·74 | 49·00 | — |
| H .. .. | 8·81 | 9·23 | — |
| Br .. .. | 41·45 | — | 41·83 |

The sp. gr. of this octyl bromide was found to be 1·1836.

*Nonylene.*

The fraction 140—141°, tenth distillation (atmospheric pressure) was selected for the addition of hydrobromic acid. In fractioning the bromide *in vacuo*, after the separation of the portion not affected by the acid, the temperature rapidly rose to 110°, and more of the distillate collected at 110—113° than at any other point in this vicinity. This product was less stable than the lower homologues, but its boiling-point under atmospheric pressure would probably be in the vicinity of 200°. Upon analysis it gave values required for bromnonane:—

I. 0·1798 grm. oil gave 0·3481 grm. $CO_2$ and 0·1501 grm. $H_2O$.

II. 0·2117 grm. oil gave 0·1888 grm. AgBr.

| | Calculated for $C_9H_{19}Br$. | Found. I. | Found. II. |
|---|---|---|---|
| C .. .. | 52·17 | 52·80 | — |
| H .. .. | 9·18 | 9·33 | — |
| Br .. .. | 38·65 | — | 37·96 |

The sp. gr. of this bromnonane was 1·2084.

Higher fractions failed to give us addition products with hydrobromic acid, either because the additive power of the hydrocarbon was too weak, or because, if the addition product were formed, it was decomposed by distillation *in vacuo*. The first explanation is probably correct, since we have never noticed the evolution of hydrobromic acid in any considerable quantity. Perhaps it is more reasonable to assume that our distillates contained no higher homologues of this series than those that were identified.

With reference to the solvent power of sulphuric acid for the hydrocarbons described above, it is doubtless true that compounds with this acid of the hydrocarbons with high molecular weights are less stable, and partake more of the nature of mechanical solution. It is doubtless also true that the mechanical solvent power of the acid is increased by the other oils that the acid dissolves. If the acid solution separated from the oil be neutralised with calcium hydroxide, certain lime salts are formed, crystallising in long needles, and consisting, at least in part, of nitrogen bases, but sulphonates of the ethylene hydrocarbons and of allied series have not been observed. That unsaturated hydrocarbons may be extracted by sulphuric acid and precipitated by dilution, has been shown in several experiments. We diluted a carboy of sludge acid by pouring slowly into water, and found the precipitated oils to contain these hydrocarbons. As to their relative proportion in the crude oil we have no precise data, but in comparison with the principal constituents it is extremely small.

Since the sulphur compounds described in this paper, as well as the alkyl sulphides, are also readily soluble in sulphuric acid, they should be removed as a part of the sludge in refining burning oil distillates.

The results described in this paper may be summarised as follows:—The separation from Canadian petroleum of the following series of sulphur compounds: Hexyl, heptyl, octyl, nonyl, decyl, undecyl, quatdecyl, sexdecyl, octodecyl thiophanes; the formation of corresponding sulphones by oxidation.

Canadian petroleum contains, in minute proportions, unsaturated hydrocarbons, $C_nH_{2n}$, apparently of the ethylene series. Canadian petroleum contains certain sulphur-free oils soluble in alcohol, and different in odour and in other respects from the series hitherto identified in petroleum, possibly terpenes.

We desire to acknowledge our obligations to Messrs. C. A. Lattimer and R. C. McBride for assistance in the purification and analysis of the sulphur compounds.

## NOTES ON TYPEWRITER RIBBONS.

By A. M. DOYLE.

It is only within comparatively recent years that typewriter machines have been perfected so as to be of practical use. The advantages of such a mechanical contrivance were so great, however, that they were quickly recognised by business men, and the use of the machine has to-day become so general that it has almost completely replaced the old style of longhand writing. Naturally questions have arisen as to the character of the records made, especially as regards permanence. This question was investigated in 1890 by Mr. Thomas Antisell, Chemist of the U.S. Patent Office, his results being published in the report of the Commissioner of Public Records of the State of Massachusetts. Other than this report, the writer has been unable to find any literature on the subject of typewriter ribbons.

The Bureau of Chemistry has received requests for information in regard to the character of records made by typewriter ribbons, and these, as well as the need for data to guide in the awarding of contracts, have led the Contracts Laboratory to make the following investigation. The writer is indebted to Mr. L. S. Munson, Chief of the Contracts Laboratory, for many valuable suggestions that were of assistance throughout the work.

Samples were obtained from the Supply Divisions of the various departments and from operators in the Department of Agriculture. The total number of ninety-nine ribbons included fifty-nine new and forty old ribbons, representing forty-three brands and nineteen manufacturers. There were 31 record ribbons (mainly black record), and 68 copy ribbons, among which were 30 indelible copy, 11 black copy blue, 12 blue copy, 11 purple copy, and 4 of other kinds.

Operators sending samples of old ribbons were asked to state the length and quality of service rendered by the ribbon, and in this manner information was gathered from a large number of workers. Complaint was made that the ink gummed or smeared; that there was too much ink, clogging the type and making frequent cleaning necessary; that, on the other hand, some ribbons contained an insufficient amount of ink, and therefore did not clog the type, but were not enduring; that ribbons were unevenly inked, giving spotted writing; that the writing of some ribbons, notably that of the purple copy, faded readily, and that the fabric forming the basis of the ribbon wrinkled and stretched along the edges and wore badly in holes.

The length of service as reported varied from less than three weeks to more than seven months, the general idea being that a ribbon should last from six to eight weeks. Very much depends, however, upon the touch of the operator and the action of the machine, as well as the use for which the writing is intended. The amount written by one ribbon was variously reported to be from 264 pages to 2100 pages; the number of words was estimated to be from 109,000 to 630,000, which shows that great differences exist, not only in the amount of work done, but in the methods of estimating it.

The work of the investigation was conducted along three general lines:—

1. Tests to show the quality of the ribbon fabric—width, total length, weight per square centimetre inked and clean, tensile strength, number of threads in warp and woof, and the metric yarn number.

2. Tests to ascertain the nature of the ink—moisture, ash, lampblack, dye, oil, total inking material and clean ribbon, determining the kind and quantity of each.

3. Rating of writing and copy on a scale of ten, and the action of reagents on the written matter by exposure to sunlight, water, 10 per cent ammonia, 2 per cent hydrochloric acid, two-hundredth-normal bleaching powder.

### 1. *Tests of Fabric.*

In the accompanying summary (Table I.), the figures were taken from a detailed tabular statement, and show the average

TABLE I.

| Kind of test. | Kind of ribbon. | Number of samples. | Unit of measure. | Variation. | Average. |
|---|---|---|---|---|---|
| | | *New Ribbons.* | | | |
| Width .. .. .. .. | Wide .. .. | 61 | C.m. | 3·4—3·8 | — |
| | Medium . .. | 7 | | 2·4—2·6 | — |
| | Narrow.. .. | 31 | | 1·0—1·2 | — |
| Total length .. .. .. | Wide .. .. | 68 | Feet | 19·00—28·50 | 25·50 |
| | Narrow.. .. | 31 | | 29·50—54·50 | 42·80 |
| Weight, sq. cm., inked .. | Record .. .. | 20 | M.grm. | 8·50—11·76 | 9·80 |
| | Copy .. .. | 39 | | 7·26—11·68 | 9·49 |
| Weight, sq. cm., clean .. | Record .. .. | 20 | M.grm. | 5·58—8·76 | 6·47 |
| | Copy .. .. | 39 | | 4·79—7·62 | 6·15 |
| Tensile strength .. .. | Wide .. .. | 35 | Pounds | 26·50—50·30 | 38·80 |
| | Narrow.. .. | 20 | | 11·70—27·80 | 20·60 |
| Number of threads .. .. | Wide .. .. | 48 | — | 48×43—58×56 | 54×52 |
| | Narrow.. .. | 28 | — | 50×49—63×47 | 59×45 |
| Metric yarn number .. | Wide .. .. | 48 | — | 50—105 | 85 |
| | Narrow.. .. | 28 | — | 65—110 | 85 |
| | | *Old Ribbons.* | | | |
| Weight, sq. cm., inked .. | Record .. .. | 11 | M.grm. | 8·21—11·37 | 10·11 |
| | Copy .. .. | 29 | | 7·55—11·47 | 9·42 |
| Weight, sq. cm., clean .. | Record .. .. | 11 | M.grm. | 5·88—8·59 | 7·61 |
| | Copy .. .. | 29 | | 4·89—8·23 | 6·62 |
| Tensile strength .. .. | Wide .. .. | 14 | Pounds | 16·50—39·10 | 27·10 |
| | Narrow.. .. | 6 | | 11·50—22·70 | 19·50 |

TABLE II.

| Number of samples from one manufacturer. | Variation, inked ribbon. | Per cent. | Variation, clean ribbon. | Per cent. | Average. Inked. | Average. Clean. |
|---|---|---|---|---|---|---|
| 31 | 7·97—10·02 | 23 | 4·93—6·29 | 23 | 8·92 | 5·90 |
| 16 | 8·51—11·68 | 30 | 6·08—8·23 | 30 | 10·63 | 7·17 |
| 12 | 8·98—10·74 | 18 | 6·18—7·90 | 25 | 9·86 | 6·93 |
| 11 | 8·50—10·75 | 24 | 4·96—6·18 | 21 | 9·26 | 5·72 |

TABLE III.

| Kind of test. | Number of samples. New. | Number of samples. Old. | Variation, both new and old (per cent). | Average (per cent). New. | Average (per cent). Old. | Average (per cent). Total. |
|---|---|---|---|---|---|---|
| Moisture, or matter volatile at 100° C. .. | 59 | 40 | 2·67—6·06 | 4·28 | 3·68 | 4·05 |
| Ash . .. .. .. .. .. .. .. .. | 58 | 22 | 0·43—15·24 | 2·48 | 1·82 | 2·27 |
| Lampblack, record .. .. .. .. .. | 18 | 8 | 0·88—7·00 | 3·18 | 2·32 | 3·03 |
| Lampblack, copy .. .. .. .. .. | 22 | 18 | 0·25—3·44 | 1·57 | 1·54 | 1·56 |
| Dye .. .. .. .. .. .. .. .. .. | 31 | — | 3·34—9·26 | 5·85 | — | 5·85 |
| Oil .. .. .. .. .. .. .. .. .. | 59 | 22 | 15·43—31·02 | 22·09 | 19·40 | 21·26 |
| Total ink .. .. .. .. .. .. .. | 58 | 40 | 20·56—46·00 | 34·78 | 28·42 | 33·38 |
| Clean ribbon . .. .. .. .. .. .. | 58 | 40 | 79·44—54·00 | 65·22 | 71·58 | 66·62 |

for each test, as well as the variation. The figures for old ribbons in width, length, number of threads, and yarn number were about the same as for new ribbons, and were therefore included among them.

The varying widths of ribbons adapt them for use on different machines. In all totals, medium width ribbons were included among wide ribbons. In length, wide ribbons varied from 19 feet to one-half as much more, and narrow ones ranged from 29 feet to nearly twice the amount, the averages being 25·5 and 42·8 feet respectively.

Considering the weight per square centimetre, the weight of the inked ribbons, both new and old, varied as much as one-third of the average weight; the weight of the clean ribbons varied as much as one-half of the average weight; and these variations were as much or greater than the total amount of the ink found by taking the difference between the totals for inked and clean ribbons—that is, the average weight of ink was found to be about one-third the weight of the ribbon, and the variation among different ribbons equalled or even exceeded the weight of ink. The average weight of the inked ribbon differed very little whether the ribbon was old or new. The averages for 59 new and 22 old ribbons, eliminating certain abnormal figures which appear in the above totals, were 9·60 and 9·34 m.grms. per sq. c.m. respectively. Inasmuch as all of the old ribbons were reported by operators to be in an exhausted condition, it would appear that the exhaustion of a ribbon depends more upon the wear of the fabric than upon the amount of ink removed. In connection with the weight per square centimetre, the evenness of the inking was tested by comparing the weights of ten or more sections of the same ribbon. The strips, which were about 35 c.m. long, weighed approximately 1 grm., and were found to vary as much as 10 per cent of the average weight. Shorter lengths would probably have shown greater differences.

Table II. shows the variation and averages of the weights per square centimetre for the products of the same factory.

The variation, calculated on the average weight, ranged in the inked ribbon from 18 to 30 per cent, and in the clean ribbon from 21 to 30 per cent. The variation for clean ribbon, therefore, was equal to or greater than that for the

inked ribbon, which would seem to show that the ribbon fabric varies rather than the quantity of ink. In the last line, where an exception may be noted, the eleven samples were obtained at the same time from the manufacturer, and there was noticeably less variation in the strength of the material as determined by the tensile strength tests. It is possible, therefore, that a part of the variation may be due to the varying ages of the ribbons, but, aside from this, it is evident that the weight of the material employed by manufacturers is far from being uniform.

The figures for tensile strength represent each an average of at least ten, frequently twelve or fifteen determinations. One inch of the ribbon was tested at a time, and so great were the differences between sections that a fair average was obtained only by a large number of tests. Many of the ribbons showed differences of as much as 7½ pounds in successive tests on the same ribbon, while the maximum difference for the same ribbon was 12 pounds. Comparing different ribbons, some bore fully twice the strain of others in the same class. Old ribbons, as might be expected, were of less strength, the total difference being marked in the case of wide ribbons, but obscured in the total for narrow ribbons because of the presence of selvage.

The number of threads, warp and woof, and the metric yarn number were ascertained by Mr. B. J. Howard, Chief of the Microscopic Laboratory. The number of threads, which were directly counted under a microscope with micrometer attachment, together with the weight per square centimetre of the clean ribbon, gave the yarn number, according to a formula worked out by Herzfeld (see "Yarns and Textile Fabrics"). The number of threads, yarn number, and tensile strength would naturally be closely related, but the results did not establish such relation, possibly because the date of manufacture was not considered. Ribbons may become weak and even fall to pieces in time, owing to the presence of corrosive materials in the ink, and it is therefore probable that the apparent lack of agreement in the three sets of figures is due to the fact that the ribbons had been on hand for a greater or less length of time.

### 2. *Tests of Ink.*

In the summary of the tests for the ink (Table III.), the averages for the new and old ribbons were separated, but the variation differences were not great enough to make two statements necessary. In all of the tests the variation among ribbons, both new and old, was very wide. The volatile matter, determined by heating to constant weight at 100° C., averaged about six-tenths lower in old ribbons, showed practically no variation from day to day, but lessened gradually as the ribbon aged. The ash, which was determined by burning off carbonaceous matter at a low red heat, varied in general between 1 and 2 per cent. From 3 to 5 per cent is a high ash content, and above 5 per cent is very unusual. The kind and quantity of ash give valuable indications of the colouring matter used for the ink.

The determination of the lampblack was very difficult because it was almost impossible to separate it from the fibres of the ribbon. Of the several methods tried but two gave any measure of success, and these agreed only within two or three-tenths of a per cent. In one method the cotton material was dissolved away by strong sulphuric acid, and the resulting solution passed through a Gooch filter which retained the lampblack. The other method consisted in separating the lampblack mechanically in ethereal and alcoholic solution by shaking and rubbing, the carbon being collected on a Gooch crucible. The latter method allowed of a direct weighing of the cotton skeleton of the ribbon, and for this reason was the preferred method. All of the black record, black-copy-blue, and indelible copy ribbons contained lampblack, copy ribbons averaging about 1·5 per cent, and record ribbons about twice as much.

On treating the ribbon with ether to extract the oil and filtering through a Gooch crucible, it frequently happened that the dye as well as the carbon was filtered out. After removal of all of the oil by ether, the ribbon and crucible were both dried and weighed. They were then treated with alcohol and water, and sometimes strong acid, which removed the dye, and, after drying and again weighing, the dye was found by difference, This method gave excellent results, Methylene blue, which was very commonly used, was determined by titration with a standard solution of Krystal Ponceau, according to a method worked out by E. Pelet and V. Garuti, published in the *Bulletin de la Soc. Chim. de Paris.* Duplicate tests agreed within 0·05 per cent. The summary gives the results of 31 determinations of methylene blue made by this method.

The oil was determined by extraction with ether and direct weighing. The amount of oil, which appears to influence the working qualities materially, averaged about 22 per cent. Much less shortens the life of the ribbon, and much more clogs the type and makes the writing blurred, while the length of service is not correspondingly increased.

The figures for total writing material equal the difference between 100 per cent and the total clean ribbon. Not a very close relation seems to exist between total ink and ribbon efficiency, although as a rule those ribbons having high working qualities possessed more than the average amount of ink, made up of more than average content of oil and dye. The total ink of ribbons of a popular make ranged from 27 to 38 per cent, showing that wide variation is possible in ribbons giving general satisfaction. Ribbons of much less than average ink may possess good working qualities for a time but they do not last well. Those with low percentage of either dye or oil seldom work well and low amounts of lampblack detract from the permanence of the writing. The percentage of available ink was roughly determined by taking short pieces of the ribbons, weighing, using to the point of exhaustion, and again weighing. Of the 27 ribbons thus treated, the loss ranged from 1·8 per cent to 16·5 per cent, with an average of 8·0 per cent calculated on the actual space exhausted. This agrees very well with an average loss of about 6 per cent of the total ribbon, shown in the summary of tests. The ribbons yielding the greatest amount of available ink, in the above test, did not as a rule give a larger amount of writing, but rather showed a tendency to clog the type and blur the writing, showing that the ink flowed too freely. One ribbon wrote twice the number of lines that any other ribbon was able to do, and contained 13·5 per cent of available ink. This ribbon contained high percentages of moisture and of dye, but only average amounts of the other ingredients. It is to be regretted that but one of this make of ribbon was examined.

### 3. *Tests of Writing.*

In the rating of the writing and the copy, the best was assumed as a standard, ranked one, and the other figures up to ten show a gradation from clear, strong impressions to writing that is barely legible. The effect of reagents was also rated on a scale of ten, ranging from one, or "unaffected" to ten, or "completely effaced." In all of the tests the uncopied writing, the copied writing, and the copy were similarly treated. The sunlight test, which was very severe, consisted in exposing the three kinds of writing, under glass, to the direct rays of the sun for ten days. Very weak solutions of the wet reagents were employed, but these, too, proved to be rather severe when applied for twenty-four hours. In a general way it was found that in treatment with reagents the original writing was severely attacked, the copied writing was less so, and the copy was completely effaced. With few exceptions record ribbons furnished permanent records, and the original writing of those copy ribbons that contained lamp-black was permanent, but the copies were not. Copy ribbons failed to give indelible copies because almost none of the carbon was transferred. On exposure of the copy to sunlight for ten days or less, the dye faded out completely,

leaving the writing illegible. Most of the ribbons were very satisfactory when fresh, both the original and the press copy being good, but marked differences in the quality of the records were developed by wear, a number which gave good results at first being quickly exhausted.

From the foregoing it may be seen that ribbons of different makes differ widely in their properties; that ribbons of the same make differ as widely; that the ribbon itself is of uneven construction; that the fabric, more than the ink, is the cause of these variations; that many record ribbons furnish permanent records, and that much is yet to be desired in the attainment of truly indelible copy ribbons. It is evident that there is need for definite requirements to regulate the purchase of typewriter ribbons, especially as regards the material which is employed as a basis for the ink. An essential of a good ribbon is that the fabric be of the quality best fitted to endure the special kind of service required until all ink available for good writing is exhausted.—*Journal of the American Chemical Society*, xxviii., No. 6.

## MEMORANDUM ON DRY CLEANING.*

In 1896 a Departmental Committee reported upon the precautions necessary for the safety of persons employed in the process of dry cleaning. The recommendations of the Committee have been largely adopted, with satisfactory results, but accidents of a severe and sometimes fatal character are still reported from time to time. In the light of further experience it is now possible to suggest additional measures of precaution, directed more especially against the risk of ignition by electric sparks, which is now recognised as the cause of most instances of so-called spontaneous firing of benzine.

Textile fabrics (especially undyed wool and silk) and many other materials become electrified when rubbed or when moved quickly in benzine, and sparks may result causing explosion. The risk of sparking is greatly increased when the air is exceptionally dry, *e.g.*, in frosty weather; and if the relative humidity of the air falls much below 70 per cent of saturation, moisture should be added, by steaming or otherwise. This can easily be done if steam jets are available.

(The degree of moisture or dryness of the air can be determined readily by means of the hygrometer. There are several forms of this instrument, obtainable at small cost. The one in common use is known as the *wet and dry bulb hygrometer:* instructions as to its use will be given on application to H.M. Inspectors).

Benzine may be rendered less liable to ignition by electric sparks by the addition of small quantities of certain soaps or other chemicals. For example, "antibenzinpyrin" or the oleate soap mentioned in the Committee's Report;† the proportion to be added does not exceed 1 part in 1000 of spirit. The use of soap in benzine appears to have become general except in rinsing, and to have contributed to the immunity from fire.

All vessels (hydro-extractors, washing and rinsing machines, &c.) containing inflammable spirit should have adequate covers, and should as far as practicable be kept closed during use. The covers should, moreover, be balanced, so that if forced open by explosion they will fall back by their own weight, and cut off the air supply from the burning spirit; or in the case of rinsing vessels which cannot be kept closed during use, an iron cover should be suspended from above by a cord passing to a catch at some distance from the vessel, when in emergency it can be immediately set free so that the cover will fall. Attention is also directed to the special safety appliances, such as the Nonex, which are now available for the storage of inflammable spirit.

Used spirit should be conveyed in closed pipes, without exposure to air, to the settlers or still, which should be in a room set apart for the purpose.

Naked lights should not be used in a benzine room. Where incandescent electric light is available, the burners should be in a double air-tight glass cover. Failing electric light, the room should be lit from outside, through an air-tight window.

By such means the risk of fire and explosion can be greatly lessened, but it is still necessary to make provision for minimising these effects. There should be an ample water supply, with hydrants and hose, in order to prevent the extension of flames, but water should not be used in attempts to extinguish burning spirit. For the latter purpose blankets and a supply of sand should be kept in readiness. Steam jets will be useful in the event of fire, as well as for the preventive purpose of humidification when the air is dry.

All persons employed should wear woollen or other non-inflammable outer garments.

As a fire may cut off the ordinary exit by the door, there should be alternative means of escape by an outside staircase, if the room is not on the ground floor. All persons employed should have clear instructions what to do in case of fire.

Ample space and free ventilation, desirable on other grounds, also tend to lessen the risk of accidents.

Apart from the risk of fire and explosion, injury to health may result from breathing the fumes of benzine, &c., and care should be taken to make the exposure to those fumes as brief as possible. Meals should not be taken in rooms in which inflammable spirit is used, and suitable accommodation should be provided elsewhere. It is desirable that women and young persons exposed to the fumes should be periodically examined by the Certifying Surgeon, in order that if their health is found to suffer from their occupation they may discontinue it either permanently or for such a time as he may direct.

H.M. Inspectors of Factories will be glad to advise in further detail if desired.—B. A. Whitelegge, Chief Inspector of Factories.

Home Office, October, 1906.

* Factory and Workshop Act, 1901.

† "To prepare such a soap, dissolve 1 kilo. of caustic potash or caustic soda in 4 kilos. alcohol. To each litre of this solution add 1½ litre oleic acid, and heat the mixture. To keep the salt in solution add to every 100 parts of the mixture, either before or after heating, 250 parts carbon tetrachloride, benzol, benzine, or other suitable solvent. Any other soluble oleate may also be employed.

# CORRESPONDENCE.

## ESTIMATION OF THE HALOGENS IN ORGANIC SUBSTANCES.

*To the Editor of the Chemical News*

Sir,—With regard to the interesting note by Mr. L. H. Berry, A.I.C., in the Chemical News of October 19th (vol. xciv., p. 188), on the above subject, I adopted this convenient little method for chlorine determinations nearly twenty years ago, the original idea being taken from a journal.

The following modifications of the method were found advantageous:—Three hooks formed of bent platinum wires are fixed to a long wire, the hooks passing over the edge of the small platinum crucible. The weighed substance is then mixed with pure powdered quicklime, placed in the crucible, pressed down, and the latter inverted in the larger crucible, the space being filled in with coarser material. No sodium carbonate was used; a blowpipe is unnecessary provided the flame is large, the crucibles being heated over a large Bunsen burner, applying the heat gently at first. When cool the long wire, which may have been coiled round the outer crucible for convenience, is

carefully straightened, and thus forms a handle to the small crucible. The whole is placed in a beaker and covered with water, and then the small crucible raised by means of the wire. Without these precautions a cloud of the material is thrown up on separating the crucibles; the wire is also a convenience in holding the small crucible when washing out the product. After acidulating with nitric acid carbon has to be removed by filtration, and the chlorine in the accumulated filtrate and washings is estimated in the ordinary gravimetric way. Mairogallol, the condensed chlorine derivative from pyrogallol, after re-crystallisation from benzene, gave by this method:—50·34 per cent chlorine; calculated, $C_{18}H_7Cl_{11}O_{10}$ = 50·4 per cent chlorine.

It is noteworthy that the error is on the wrong side in the case of chloral hydrate in Mr. Berry's note, the percentage of Cl being too high; perhaps the introduction of sodium carbonate would account for this, as it is difficult to obtain the salt free from chloride.—I am, &c.,

C. S. Stanford Webster.

Elm Lane, Redland, Bristol,
October 20, 1906.

## NOTICES OF BOOKS.

*A History of Chemistry.* By F. P. Armitage, M.A., F.C.S. London, New York, and Bombay: Longmans, Green, and Co. 1906.

A complete history of chemistry of moderate size and price will certainly be regarded as a boon by the earnest student, and this book is admirable in many ways, the only matter for regret being the fact that the author saw fit to bring the subject down only to the enunciation of the Periodic Law by Newlands. The emphasis laid upon the most important agents in the development of the science and the avoidance of too great a mass of detail will recommend the book even in the eyes of those who have access to similar but much larger works, and by judiciously compressing the pre-Lavoisierian period the author has given himself room for a fuller account of the work of chemists of later date; in particular, we may mention the vivid picture drawn of the striking personality of Berzelius. Moreover, the stories of some of the discoveries are worded so skilfully that something of the zest and enthusiasm of the original investigator is transmitted to the reader; for example, the account of Wöhler's synthesis of cyanic acid, and the important questions which it brought to light, is very graphic and inspiring.

*Second Report of the Wellcome Research Laboratories at the Gordon Memorial College, Khartoum.* By Andrew Balfour, M.D., B.Sc., F.R.C.P. (Edin.), D.P.H. (Camb.), Director. Khartoum: Department of Education, Sudan Government. 1906.

The second report of the Wellcome Research Laboratories is a record of steady progress in the valuable work which is being done by the Director and his staff. The greater part of the book is devoted to the reports of the biological and bacteriological work done in the laboratories, and is beautifully illustrated by valuable and in some cases unique photographs. As regards the chemical department, to the head of which Dr. William Beam has been comparatively recently elected, much work has been done in analysing the waters of the Nile, seeds of various kinds, and milk, while an important series of researches on gums has been begun, which should have a valuable influence upon the development of the Sudanese gum industry. Although most of the work is necessarily of a routine nature it is interesting to notice that some new practical suggestions have emanated from this laboratory; such are the improved form of hydrometer, in which a float facilitates accuracy of readings, and a simplification of the mode of determining crude fibre with an inverted condenser. The apparatus shown is certainly worth a trial by analysts, especially by those who do much agricultural work, although it might appear that the danger of breakage by bumping would be much increased unless special measures were taken to prevent it.

*German Scientific and Technological Reader.* Books I. and II. By E. Classen, B.A., and J. Lustgarten, M.Sc. London and New York: Harper and Brothers. 1906.

It is now generally acknowledged that some knowledge of German, sufficient at any rate to enable him to read the language easily, is absolutely indispensable to the student of science and technology, and these two volumes are designed to provide material for reading, graduated in difficulty. Volume I. begins with easy passages, such as a student who has no previous knowledge of the language should be able to cope with, the subjects being connected with physics, chemistry, and various branches of technology; a vocabulary is provided, but is hardly an acquisition, for in many respects it is not nearly full enough, words which are not used in the usual sense in the text being wanting, while, on the other hand, many which have the same form in English as in German are included; thus, we find Nickel and Mangan given, but Vorlage is not translated. Moreover, the vocabulary is not by any means free from errors; for instance, Knallgas does not mean hydrogen, nor Kalk calcium, and Brennweite is also incorrectly rendered. The second volume contains extracts of greater difficulty, without vocabulary or notes, and it seems probable that the student who could translate them unaided would probably be able to manage an original paper of ordinary difficulty, or at any rate would be spending his time more profitably in the attempt.

## CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxliii., No. 14, October 1, 1906.

**Constituents of Manganese and Molybdenum Alloys.**—G. Arrivant.—The author described in a previous paper his method of preparation of a series of manganese and molybdenum alloys containing two definite constituents, $Mn_6Mo$ and $Mn_4Mo$. He now investigates alloys richer in molybdenum. The fusion of the latter is difficult to effect by means of a Schlœsing furnace, but by reducing by means of aluminium powder mixtures of oxides in suitable proportions, an alloy containing 75 per cent of molybdenum can be obtained. The substances thus prepared are generally free from aluminium. The alloys are hard, more so as the proportion of molybdenum is increased; they are not magnetic, and the air has no action upon them, but nitric acid completely dissolves them, forming molybdic acid when heated. The author is able to separate three distinct constituents, corresponding to the simple formulæ $Mn_2Mo$, $MnMo$, and $MnMo_2$, and on examination finds them to consist of crystalline metallic powders of steel-grey colour, non-magnetic, and produced with contraction; their density at 0° being higher than the theoretic density.

**Syntheses in the Quinoleic Group. Dicarbonic-dihydrophenylnaphthoquinoleinic Ether and its Derivatives.**—L. J. Simon and Ch. Manguin.—The base phenylnaphthoquinolein, $C_{19}H_{13}N$, is slightly soluble in

boiling alcohol, and, on cooling, crystallises in white flakes. It is slightly soluble in ether, but its best solvent seems to be acetic acid. Its solutions show blue fluorescence. It melts at 188—189° and distils without decomposition at 360°. The authors isolate and analyse the picrate, chlorohydrate, bichromate, and chloroplatinate, and identifies the base with that prepared by Döbner. The identity of the two bases also leads them directly to conclude the identity of the two acids.

## MISCELLANEOUS.

**Appointment.**—Dr. H. A. D. Jowett, who has been appointed manager of works of Burroughs Wellcome and Co., for nearly ten years acted as chief research chemist under Dr. F. B. Power in the Wellcome Chemical Research Laboratories, and during his connection with these laboratories he conducted a number of important investigations, notably on the chemistry of the jaborandi alkaloids, the constituents of cascara, &c. In October, 1905, he relinquished that post on his appointment as Chief of the Experimental Department at the Dartford Works of Burroughs Wellcome and Co. Dr. Jowett has distinguished himself at every step of his career. A Bell scholar in 1891, he passed the minor and major examinations of the Pharmaceutical Society, and secured the Pereira Medal and Redwood Scholarship in 1892. The year following he graduated as B.Sc. London. Between 1894 and 1896 he acted as Assistant Lecturer in Chemistry to the Pharmaceutical Society and Demonstrator in its Research Laboratories; and in 1896 took his degree of Doctor of Science at the London University. During the present year he has been elected a Member of Council of the Chemical Society.

## MEETINGS FOR THE WEEK.

THURSDAY, Nov. 1st.—Chemical, 8 30. "A Development of the Atomic Theory which correlates Chemical and Crystalline Structure and leads to a Demonstration of the Nature of Valency," by W. Barlow and W. J Pope. "Explosive Combustion of Hydrocarbons" (II) by W. A. Bone, J. Drugman, and G. W. Andrew. "Contributions to the Theory of Solutions—I., Nature of the Molecular Arrangement in Aqueous Mixtures of the Lower Alcohols and Acids of the Paraffin Series; II., Molecular Complexity in the Liquid State; III., Theory of the Intermiscibility of Liquids," by J. Holmes. "The Hydrolysis of Nitrocellulose and Nitro-glycerin," by O. Silberrad and R. C. Farmer. "Determination of the Rate of Chemical Change by Measurement of the Gases Evolved," by F. E. E. Lamplough. "Experiments on the Synthesis of the Terpenes—IX., Preparation of δ-Ketohexahydrobenzoic Acid (δ Ketocyclohexanecarboxylic Acid) and of γ-Ketocyclopentanecarboxylic Acid," by F. W. Kay and W. H. Perkin, jun.; X., "Synthesis of Δ'-*m*-Menthenol (8) and of Carvestrene," by W. H. Perkin, jun., and G. Tattersall. "Some Derivatives of Catechol, Pyrogallol, Benzophenone, and of other Substances allied to the Natural Colouring Matters," by W. H. Perkin, jun, and C. Weizmann.

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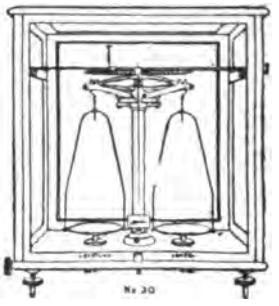

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## THE CAUSE OF THE FOGGING OF PLATES IN TROPICAL CLIMATES.

By JOHN McDOWALL, F.C.S.

SOME time ago, while in Upper Egypt, I had occasion to use a full-plate camera with wooden double dark slides. I found the plates to be nearly always fogged, notwithstanding the fact that the slides were perfectly light-tight and all the ordinary precautions of the dark room were taken.

The fogging sometimes showed itself as an opaque clouding all over the plate; sometimes the outline of the woodwork of the slide could be seen, and sometimes the grain of the wood was distinctly visible.

Shortly after I had made these observations, an eclipse of the sun occurred which was total at Assuan, and many scientific men went there to photograph it. On developing their plates, they found that many of them were rendered worthless or their value as a scientific record was greatly diminished by the same kind of fogging which I have described, and they were at a loss to explain it, although some suggested radio-activity as a cause. I have recently investigated this, and herewith give what appears to be the explanation.

I took a quarter-plate double dark slide and placed two Special Rapid plates in it. On the one plate I put a thin piece of tissue paper, in the centre of which I had cut out a star-shaped hole; on the other plate I put an ordinary glass microscopic slide. These objects were inside the slide, and in actual contact with the film. I then placed the double dark slide in a metal box and heated it up to about 40° C., which is the average temperature of Upper Egypt in the summer time. The slide was placed on a porcelain support in the metal box, which was heated by a lamp.

After heating for fifteen hours I developed the plates, and found them to be very strongly fogged, the film being quite opaque; but under the place where the thin tissue paper was, and also under where the microscopic slide was, there was no fogging. In the centre of the tissue paper I had cut a star-shaped hole, and on the plate opposite this was a star-shaped mark which was quite opaque.

I tried various other objects, and found that they acted in a similar manner.

The fact that the agent which produced the fogging could not penetrate glass or transparent tissue paper shows that it cannot be due to ethereal vibrations at all of the nature of light. It is due to vapours which are occluded in the wood at ordinary temperatures, but which are exhaled when the wood is heated. These vapours, which may be peroxide of hydrogen or volatile organic compounds from the varnish, possess the chemical property of reducing the salts of silver which are contained in the film, so that on development the plate appears to have been exposed to the light.

I tried another experiment by fixing a piece of brass tubing in a hole cut in the slide and making the joint light-tight, a plate was then put in and the whole heated to 40° C. in the metal box as before.

The brass tube was connected to a water-pump, by which the vapours in the immediate vicinity of the tube were aspirated out. The fogging appeared to be less under the place where the tube was than on any other part of the plate.

The value of these experiments to the photographer going abroad is apparent. He should get a thin piece of glass or mica with which to cover the plate in the dark slide and protect it from the vapours, and fogging would be entirely prevented by this means.

If the dark slide was opened and heated for some days, there is little doubt but that the vapour which causes the fogging would be expelled, and it could then be used with confidence in the tropics.

The simplest method of preventing the fogging is to paste a piece of paper over the inside of the wooden sliding pieces which are pulled out when the plate is about to be exposed, which effectually prevents the vapour from diffusing out of the wood on to the photographic plate.

## SOME APPLICATIONS OF THE THEORY OF ELECTRIC DISCHARGE TO SPECTROSCOPY.*

By Prof. JOSEPH JOHN THOMSON, M.A., D.Sc., F.R.S., &c., Professor of Natural Philosophy, R.I.

(Concluded from p. 199).

*Application of these Results to Spectroscopy.*—We have seen that the passage from the dark to the luminous discharge occurs with great abruptness, an increase of the potential difference by $\frac{1}{100}$th of a volt being sufficient under certain circumstances to convert a discharge in which no luminosity at all could be detected to one where it was quite bright. This suggests that the luminosity sets in when the internal energy of the atom—or rather of that part of it which gives rise to the particular kind of light present in the luminous discharge—attains a perfectly definite value. This way of regarding the origin of the luminosity affords a very simple explanation of the variation of the spectrum with the kind of discharge, and of the effect of introducing capacity or self-induction into the circuit containing the discharge tube. Let us consider the rise in energy of a vibrating system inside the atom. Let E be the energy at the time $t$; $\alpha$ the rate at which it is absorbing the work done in the discharge tube. The energy may be supplied to it from the Röntgen radiation in the tube, or from the corpuscles which come into collision with the atom; $\alpha$ will be proportional to the rate at which the electric field producing the discharge is doing work in the neighbourhood of the atom we are considering. It will thus be proportional to the product of the electric force and the flux of corpuscles in this neighbourhood. Let us suppose that the system radiates energy at a rate proportional to E, say, equal to $\beta$ E; then we have—

$$\frac{dE}{dt} = \alpha - \beta E,$$

or—

$$E = \frac{\alpha}{\beta}(1 - e^{-\beta t}),$$

if E = 0 when $t = 0$.

Consider two different systems A and B in the same atom. Let $E_1$, $\alpha_1$, $\beta_1$; $E_2$, $\alpha_2$, $\beta_2$ be the values of E, $\alpha$, $\beta$ for the systems A and B respectively:—

$$E_1 = \frac{\alpha_1}{\beta_1}(1 - e^{-\beta_1 t}),$$

$$E_2 = \frac{\alpha_2}{\beta_2}(1 - e^{-\beta_2 t}).$$

Now suppose that the system A is one that does not absorb much, but also does not radiate much, while B absorbs a great deal more than A, but radiates still more in proportion, so that $\alpha_2 > \alpha_1$, but $\alpha_1/\beta_1 > \alpha_2/\beta_2$, so that ultimately $E_1$ is greater than $E_2$, but at first $E_2$ is greater than $E_1$. The curves (1) and (2), Fig. 4, represent the variations of $E_1$ and $E_2$ with the time.

Suppose now that systems A and B become luminous when the internal energy is equal to W. It is not necessary to assume that the critical amount of energy is the same for the two systems, the assumption is only made to simplify the diagram; the reader will see that the argument

* A Discourse delivered at the Royal Institution, January 19, 1906.

would apply if the critical amounts of energy were different in the two cases.

Now consider first the case when the rate at which work is being done in the tube is so small that though $\alpha_1/\beta_1$ is greater than W, $\alpha_2/\beta_2$ is less than W, the case represented in Fig. 4; here system A acquires the amount of energy necessary to make it luminous, while system B does not; thus in this case the spectrum of the gas would show the lines corresponding to A but not those of B. Suppose now we increase the rate at which work is done in the tube, so that both $\alpha_2/\beta_2$ and $\alpha_1/B_1$ are greater than W, the case represented in Fig. 5.

Here the system B attains the critical amount of energy, and it reaches this value before A does, so that in this case the lines of B will be visible. Let us now consider the lines in the spectrum corresponding to the system A; these will be visible if the energy in the system reaches the critical value; the conditions in this case are in some respects more unfavourable for the supply of energy to this system than they were in the previous one. For in the first case the system B got into the condition in which it radiated as much energy as it received, and thus did not absorb any of the energy; in the second case, however, B became luminous before its radiation was equal to the absorption; it is thus taking in more energy than it gives out, and this may result in a diminution in the rate of supply of energy to A; it would do so, for example, to a marked extent if the conditions were such that A received a considerable portion of its supply of energy from B. This diminution in the supply might be great enough to prevent the internal energy in B reaching the critical value. Thus the result of the increase in the rate of supply of the electrical energy might be to weaken or even obliterate the lines of A, and while with the smaller rate we had the lines of A and not those of B, with the larger rate we might have the lines of B and not those of A. Thus an increase in the rate at which the electric field is doing work, such as would be produced by increasing the current through the discharge tube, might result in an entire change of the spectrum. We should expect that it would only be in exceptional cases that the lines of A would be obliterated under the conditions holding in case A, but in all cases the increase in the brilliancy of the lines of B would be large compared with the increase of those in A.

We see from the equations giving $E_1$ and $E_2$ that until the supply of energy has lasted for a time comparable with $1/\beta_2$, $E_2$ is large compared with $E_1$; thus for electrical discharges which last for an exceedingly short time we might easily have the lines of B visible and not those of A.

In a discharge tube conveying an electric current, the amount of work per unit volume of the gas done by the electrical forces per unit time varies very largely from one point of the tube to another. If the cross section of the discharge is the same at all parts of the tube, so that the current density is uniform, the rate at which the electrical forces do work will be proportional to the electric force. As this is much greater near the cathode than at other parts of the tube, we should expect the lines of systems of the type B to preponderate near the cathode, and to be absent or much feebler in other parts of the tube. If the tube were of the type frequently used for spectroscopic purposes, with a capillary portion in the middle, then, since the current density is much greater in this portion than in any other, the rate of work per unit volume of the gas will be much greater in the capillary portions than in the wide parts of the tube, and we should therefore expect the lines of systems of the type B to be much more prominent in the capillary part than in the wide part.

*Effect of Self-induction and Capacity.*—Suppose that we have a tube of uniform bore arranged as in Fig. 6, the terminals of the tube being connected with the plates of a condenser of capacity C, and that there is a coil whose coefficient of self-induction is L, placed in series with the tube; then if the discharge through the coil begins when the potential difference between the plates of the condenser is $V_0$, the potential difference between the plates after a time $t$ will be—

$$V_0 \cos p\,t,$$

and the current through the tube—

$$C\,V_0\,p \sin p\,t,$$

where $p = \frac{1}{\sqrt{LC}}$.

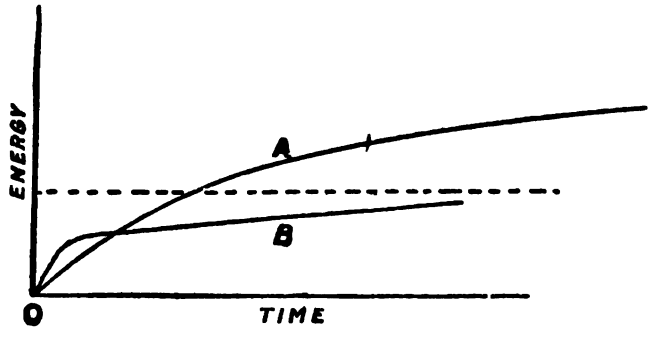


Fig. 4.

Thus the maximum value of the product of the curren and the potential difference, *i.e.*, rate at which the electric forces are doing work in the tube, is—

$$C\,V_0^2\,p, \text{ or } \sqrt{\frac{C}{L}}\,V_0^2,$$

and is thus proportional to the square root of the capacity, and inversely proportional to the square root of the self-induction. Thus, increasing the capacity increases the maximum rate of work, and therefore increases the brilliancy of the lines corresponding to systems of the type B relatively to those of type A, while inserting self-induction in the circuit increases the brilliancy of those of type A as compared with those of type B. If we suppose that the "blue" spectrum of argon corresponds to a system of type B, the red to a system of type A, we have an explanation of the changes in the spectrum of this gas, for by inserting capacity in the circuit we can change from the red to the blue spectrum, while having got the blue we can get back to the red by inserting self-induction as well as capacity. I have here a little model which is intended to illustrate the way in which the red and blue spectra of argon originate. It is based on the fact that when we send a current of electricity through a circuit, the current does not rise to its steady value instantaneously, but, starting from zero, increases with the time in exactly the same way as we have supposed the intrinsic energy in the atom, *i.e.*,

the way represented by the curve in Fig. 4. The quantity in the electrical case corresponding to the radiation $\beta$ is the resistance of the circuit divided by the self-induction, while the quantity $\alpha$ is inversely proportional to the self-induction. Thus, a circuit with large self-induction and small resistance is analogous to the system A, while one with small self-induction and large resistance is analogous to a system of type B. Now my model of the argon atom consists of two circuits, C and D, placed in parallel. C has large self-induction and small resistance, D has little self-induction but large resistance. An electric lamp is placed in each circuit. If I supply energy in one way, *i.e.*, by continuous current to the system, the red lamp in C lights up and the blue lamp in D is dark, while if fed by an alternating current, the blue lamp shines and the red is dark. It would be interesting to see whether, as we gradually diminish the self-induction, we get the whole of the lines in the blue spectrum at once, or whether the lines of this spectrum enter in groups one after the other. I have tried somewhat similar experiments with the hot lime cathode to see in a mixture of gases (mercury vapour and air) which spectrum first appeared as the rate of doing work in the gas was gradually increased. The great difficulty in this determination is that when once the luminosity begins there is such a rapid increase in the ionisation that the current through the gas and the rate of doing work increase in an exceedingly short time through a wide range of values, and thus a gradual increase in the rate of work is exceedingly difficult to obtain; on several occasions, however, I was convinced that on gradually increasing the rate of work, the mercury lines were the first to appear, and were the last to disappear, when the rate of work was reduced from a high value, at which both the nitrogen and mercury spectra were bright down to a point where the discharge ceased to be luminous.

The preceding considerations have also an important application to the difference between the arc and spark spectra. In the continuous arc discharge, although the average rate of work is much higher than in the spark, the maximum rate is very much less; in the spark discharge we have exceedingly intense current density lasting for a very short time, and while the spark is passing we have a very much greater rate of work than in the arc. Hence, the state of things in the spark will be analogous to that represented in Fig. 5, and the lines corresponding to systems of the type B will be enhanced relatively to those of type A; we conclude then that the arc lines correspond to systems of the type A, the spark lines to those of type B.

The work done in the discharge tube is probably ultimately converted for the most part into heat, so that the rate at which work is being done at any part of the tube is approximately proportional to the rate at which heat is being produced in the tube. I do not, however, regard temperature, *i.e.*, the energy due to the translation of the atoms as a whole, as having any direct connection with the production of spectra. The work done by the electric field on the corpuscles is, since the corpuscles can easily penetrate the atoms of the gas, first converted into internal atomic energy. This energy may ultimately be for the most part transformed into the energy of translation of the molecules of the gas and so appear as temperature, but it by no means follows that, if we heated the molecules of the gas by non-electrical means to the temperature to which even a few of its molecules are raised by the electric discharge, that we should get a luminous spectrum. The production of the spectrum depends upon the internal energy of the atom. When we use the electric discharge, all the work done by the corpuscles goes at first into the form of internal atomic energy, while if we supplied the same amount of energy to the gas by thermal, as distinguished from electrical means, the energy would go first into increasing the energy of translation of the atoms, and very little of it would ever get inside the atom. It is probable, however, that some of the energy of translation would get converted into internal energy, and that temperature is one way of giving internal energy to the atom and so producing luminosity. From one point of view, however, it is a very extravagant method, as the fraction of the energy spent in heating the gas which goes in producing luminosity is small.

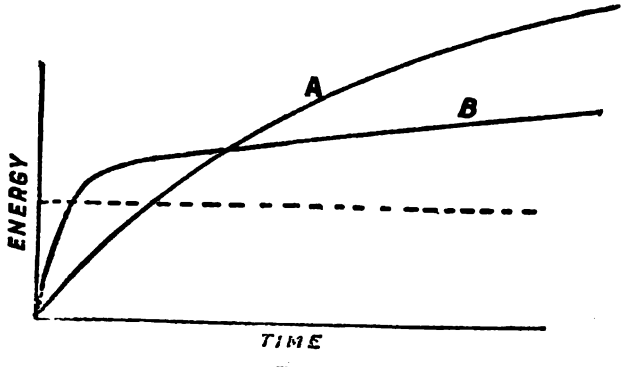


Fig. 5.

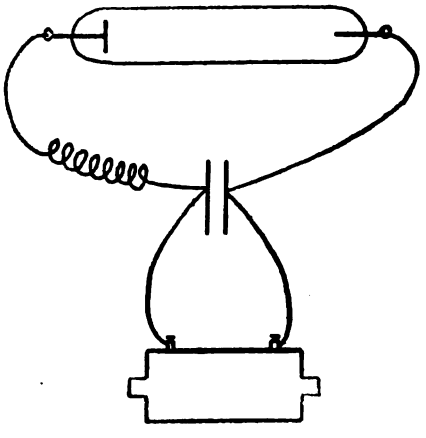

Fig. 6.

The coefficient of absorption $\alpha$ of the systems will depend upon the way in which the internal energy is given to the atom, as well as upon the rate at which the electric field is doing work in the neighbourhood of the atom. Thus, for example, if the internal work is given by means of rapidly moving corpuscles, the coefficient of absorption will depend upon the velocity of the corpuscle, for we can easily show that when a corpuscle passes at a fixed distance from a system of corpuscles having a definite period of vibration, there is one velocity of the corpuscle, depending on this period—fast if the period is short, slow if it is long—for which the energy given by the corpuscle to the system is a maximum. Thus the relation between the amounts of energy absorbed by two systems from the corpuscles depends upon the velocity of the corpuscle. The velocity of the corpuscles in a discharge tube depends upon the pressure of the gas, so that even though the rate at which the electrical forces are doing work may be the same at two different pressures, the relative intensities of the lines of two systems A and B may be different.

Again, we might expect that the coefficient of the rate

of absorption of energy would be different according as the energy is given to the atom by means of the large systems which form the positive ions, or by means of small corpuscles; and that the relative brightness of lines might be different in the two cases. In the Canal-Strahlen we have positive ions moving through gas and producing luminosity, and the spectrum of this luminosity possesses interesting peculiarities differentiating it from the spectrum of other parts of the tube. Perhaps the most striking difference, however, is when the positive ions strike against a salt like lithium chloride; they make the red lithium line appear with great brilliancy, while if corpuscles strike against the chloride the red line is not visible. It is remarkable that the spectrum of the metal is produced much more readily by the positive ions when they strike against a salt of the metal than when they strike against the metal itself. This is shown in a striking way; if we take the liquid alloy of sodium and potassium and direct a stream of Canal-Strahlen upon it, the clean parts of the alloy appear quite dark, but the specks of oxide scattered over its surface shine with a bright yellow light, giving the sodium spectrum.

When the internal energy of the atom is increased by means of light, as in Professor Wood's beautiful experiments on the fluorescence of sodium vapour, the coefficient of absorption of a system will depend upon the relations between the periods of that system and the period of the light vibrations incident upon them. Thus, as Professor Wood found to be the case, the numerous lines in the spectrum given out by the vapour alter greatly in character and wave-length when the period of the incident light is changed.

The same principles which explain the variation in the intensities of the spectra given out by two different systems in the same atom, can be applied to explain the variations in the intensities of the spectra of two gases A and B when these are mixed together. We know that under some conditions the lines of only one constituent of the mixture appear, while under others we get the lines of both the gases. Let us suppose that the lines of A appear with a lower rate of work of the electric forces than those of B, and that we send a constant current through the discharge tube. We can calculate what the electric force must be to produce from the molecules of A alone the number of ions required to carry this current; having found the electric force on this supposition, we can, knowing the current, find the rate at which the electric forces would be doing work in the tube. If this rate of work is less than that required to make B luminous, the current will be carried by the ions of A alone, and the spectrum of B will not be developed; if the rate of work on this supposition is greater than that required to make B luminous, the spectrum of B will appear, and it must take a share in carrying the current. Let us suppose that we have so much of A present that the rate of work is not sufficient to develop the spectrum of B, and consider what will happen as the proportion of A is diminished. In order to supply the number of ions required to carry the given current from the smaller number of molecules of A, the electric force, and therefore the rate of work in the tube, must, on the supposition that the current is wholly carried by A, increase, and if we continually diminish the amount of A present, the rate of work will at last reach a value sufficient to make B luminous, with the given current. This stage will give the smallest quantity of A which can, for the given current, wholly swamp the spectrum of B. The rate of work done in the tube will depend on the current going through it, and also on the pressure of the gases, so that both these quantities will influence the proportion of the gas B required to make its spectrum visible.

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**Royal Institution.**—A General Monthly Meeting of the Members of the Royal Institution will be held on Monday next, November 5th, at 5 p.m.

## THE DETERMINATION OF SMALL QUANTITIES OF COPPER IN WATER.*

By EARLE B. PHELPS.

During the past few years the question of the addition of small quantities of copper salts to water supplies as a preventative of algal growths and as an emergency disinfectant against typhoid fever germs, has received much discussion and led to many important investigations in this country as well as abroad. One result of all this work has been to indicate the need of some simple yet accurate method for the determination of the small amounts of copper with which the investigator has to deal. The method recommended by the Committee on Standard Methods of Water Analysis of the Laboratory Section of the American Public Health Association ("Report of the Committee on Standard Methods of Water Analysis," *Journ. Inf. Dis.*, 1905, Sup. No. 1, p. 1), is essentially that of Clark and Forbes (Mass. State Board of Health, Third Annual Report for 1900, p. 487). It involves the concentration of a sufficient amount of the water to yield a weighable amount of copper, the precipitation of the copper, as well as of certain other metals which may be present as sulphides, and the separation from the mixed sulphides of the lead and iron by the usual methods. The copper is then deposited electrolytically and weighed. Quantities of copper as small as 2 or 3 m.grms. are thus determined by Clark and Forbes with a mean probable error of about 5 per cent, while the determination of 1 m.grm. obviously cannot be made with a probable error of less than 10 per cent. The disadvantages of the process are, first, the necessity for boiling down a large volume of water in order to get sufficient copper to weigh with accuracy, and, second, the length of time required and the liability of error introduced by the precipitations and separations involved.

Colorimetric methods, while generally much more sensitive than the gravimetric, are greatly influenced by the presence of other substances, especially other metals and organic colouring-matter.

The writer has had occasion to make a number of such copper determinations and was moreover limited by the experimental conditions to quantities of one litre for each determination. Since the water contained at times only a few tenths of a milligrm. of copper per litre, the standard method of procedure was obviously out of the question. As a result of a study of various possible methods for the determination, a procedure was devised which seemed to combine to a satisfactory degree the requisite sensitiveness, accuracy, and simplicity. The method consists in the evaporation of a given volume of the water to about 100 c.c., the electrolytic separation of the copper from the acidulated solution, the solution of the deposited copper in dilute acid, and its neutralisation and colorimetric determination as sulphide, by comparison with standard tubes of known copper content. By this procedure it is easily possible to determine 0·1 m.grm. of copper, or if this amount were derived from a litre of water, 0·1 part per million. The accuracy is fully as great as with the gravimetric method using ten times as much of the same water.

The detailed procedure is as follows:—

*Apparatus.*—Platinum dishes of about 100 c.c. capacity to serve as anodes. Connection with the circuit is most conveniently made by placing the dish in a little mercury, contained in a shallow metal dish. To the latter is soldered a wire leading to the positive binding post.

A stout platinum wire, about 50 c.m. long, 40 c.m. of which is coiled into a flat spiral, and whose end is fastened directly to the negative binding post. The spiral constitutes the cathode.

A convenient source of electrical current. The character of the current is not so important in this case as in gravi-

* Published by permission of the Director of the U.S. Geological Survey. From the *Journal of the American Chemical Society*, xxviii., No. 3.

*Summary of Copper Determinations.*

| No. | Water. | Parts per million. Total solids. | Parts per million. Loss on ignition. | Characteristics of the water. | Substances added. | M.grm. of copper. Taken. | M.grm. of copper. Found. |
|---|---|---|---|---|---|---|---|
| 1. | Boston tap water.. | 40 | 15 | Soft, coloured, surface .. .. | None .. .. .. .. .. | 0·54 | 0·52 |
| 2. | | | | | None .. .. .. .. .. | 0·27 | 0·27 |
| 3. | | | | | None .. .. .. .. .. | 0·27 | 0·24 |
| 4. | | | | | None .. .. .. .. .. | 0·14 | 0·12 |
| 5. | | | | | None .. .. .. .. .. | 0·14 | 0·12 |
| 6. | | | | | Fe as $FeCl_3$, 5 m.grms.; Pb as acetate, 40 m.grms. .. | 0·54 | 0·54 |
| 7. | | | | | Ag as $AgNO_3$, 0·5 m.grm.; Sn as $SnCl_3$, 1·0 m.grm.. | 0·54 | 0·57 |
| 8. | Chattahoochee, Ga. | 300 | 50 | Soft; solids are red iron clay .. | None .. .. .. .. .. | 0·54 | 0·57 |
| 9. | Pecos, N. Mexico . | 2000 | 100 | Hardness of 840 parts; turbid . | None .. .. .. .. .. | 0·54 | 0·54 |
| 10. | Milk, Mont. .. .. | 750 | — | Hardness of 620 parts; clear .. | None .. .. .. .. .. | 0·54 | 0·55 |
| 11. | Colorado, Texas .. | 300 | — | Hardness of 128 parts; turbidity of 110 .. .. .. .. .. | None .. .. .. .. .. | 0·54 | 0·52 |
| 12. | Boston sewage .. | 4000 | 810 | Chlorine abnormal, about 1500. | None .. .. .. .. .. | 0·54 | 0·50 |
| 13. | Hay infusion.. .. | — | — | Colour about 300. .. .. .. | None .. .. .. .. .. | 0·54 | 0·55 |
| 14. | Straw-board waste. | 7000 | 4000 | High in CaO and organic acids | None .. .. .. .. .. | 0·54 | 0·51 |

metric processes, since only small amounts of copper are dealt with and the deposit need not be washed or dried. In the present experiments the current was supplied by two "gravity cells" in series, yielding a current through the solution of about 0·02 ampère. The current density at the cathode was about $N.D_{100} = 0·3$ ampère.

Nessler jars of the short type holding 100 c.c.

*Reagents.*—Standard copper solution. About 0·8 grm. of clean copper sulphate crystals are dissolved in water and, after the addition of 1 c.c. concentrated sulphuric acid, the volume is made up to one litre. In 100 c.c. of this solution the copper is determined in the usual way by electrolytic deposition and weighing, and the solution is diluted so that 1 c.c. contains 0·2 milligrm. copper. This solution is permanent.

Potassium sulphide reagent. An alkaline solution of potassium sulphide made by mixing equal volumes of 10 per cent potassium hydroxide solution and a saturated solution of hydrogen sulphide in water.

Nitric acid one to three and sulphuric acid one to one, both tested for copper.

*The Determination.*—Of waters carrying from 0·1 to 1·0 part copper one litre is taken. For other concentrations take proportionate amounts. Evaporate to about 75 c.c. and wash into the platinum dish. Add 2 c.c. of the dilute $H_2SO_4$ for clear and soft waters. For alkaline waters an additional amount is used to offset the alkalinity. For waters carrying much organic matter or clay, 5 c.c. of acid are added to assure the formation of a soluble copper salt. The dish is then placed in position, the cathode suspended in the solution so that it is parallel to and about half an inch from the bottom, and the circuit is closed. Electrolyse for about four hours with occasional stirring, or over night if convenient. Lift out the cathode without previously having opened the circuit, and immerse the spiral in a small amount of the dilute nitric acid, previously heated to boiling. Wash off the wire and evaporate the nitric acid solution to dryness on the water-bath. If silver is suspected to be present, add a few drops of hydrochloric acid before evaporation. Take up in water and wash into the Nessler jar. Make up to the mark and add 10 c.c. of the sulphide reagent. The colour of the copper sulphide develops at once and is fairly permanent, lasting for several hours at least. A similar tube is prepared by adding 10 c.c. of the reagent to a tube of distilled water and then adding standard copper solution in 0·2 c.c. portions until the colours of the two tubes match. If one litre of water were originally taken, each cubic centimetre of standard solution used represents 0·2 part per million of copper.

The method has been carefully tested as to the completeness of the separation and as to the influence of other substances in the water. Particular care has been taken to separate small amounts of copper from large amounts of organic matter (sewage and industrial wastes), colouring-matter in surface waters, and from salts of iron, lead, silver, and tin. As will be seen from the appended table of results the separation is in all cases satisfactory. Silver and tin appear to be, according to the authorities, the only metals which will separate out under the conditions used. Neither will be commonly met with. The silver may be converted into the chloride as indicated and does not interfere with the determination. The tin is only partially dissolved by the nitric acid and during the evaporation is converted into metastannic acid. In the alkaline solution used in the test the tin in this form does not interfere in the least.

In the accompanying table are given the results obtained in testing this method. In all cases except those in which Boston sewage and straw-board liquor (the waste liquor of a straw-board mill) were used, one litre of water was taken and the necessary solutions added to it. In the two cases mentioned only 100 c.c. were taken.

## A METHOD OF DETERMINING HYDROGEN PEROXIDE: AND FERROUS SALTS AND OTHER REDUCING AGENTS.

By W. E. MATHEWSON and J. W. CALVIN.

THE fact that soluble titanium compounds give a deep yellow compound with hydrogen peroxide forms the basis of well known qualitative tests for both substances (Schönn, *Zeit. Anal. Chem.*, ix., 41, 330). Weller's colorimetric method for the estimation of titanium also depends on this reaction (*Zeit. Anal. Chem.*, xxiii., 410; *Ber.*, xv., 2592). The intensely yellow substance formed, usually considered to be titanium trioxide or the acid derived from it, is instantly decomposed by reducing agents, and it would therefore seem that such compounds might be determined by titrating with standard solution of hydrogen peroxide, using a titanium salt as indicator. It was thought by the writers that if standard peroxide could be used in this way the process might be applied very advantageously in certain determinations. The peroxide is very reactive, and is not only capable of acting as a strong oxidising agent with most reducing substances, but can also reduce many of the stronger oxidising agents, and the method might be equally applicable to some reactions of the latter class. In this paper are given the results obtained with ferrous ammonium sulphate and sodium nitrite. These substances were chosen as they are well known reducing agents, and seemed suitable for testing the method.

*Ferrous Ammonium Sulphate.*—A standard, approximately 0·1 N solution of ferrous ammonium sulphate, containing some excess of ammonium sulphate, was prepared, several portions of different amounts measured from a burette, about 5 c.c. of phosphoric acid added, to render the solution colourless, and sufficient water to make about 50 c.c. About 5 c.c. of a solution of titanium potassium sulphate was then poured in, and the mixture titrated at once against peroxide. The titanium solution was made by fusing the dioxide with about ten times its weight of potassium hydrogen sulphate, dissolving the fused material in cold dilute sulphuric acid, and filtering. The results obtained from these titrations being quite concordant, four portions of crystallised ferrous ammonium sulphate, $Fe(NH_4)_2(SO_4)_2.6H_2O$, were weighed out, dissolved, and titrated in the same way. The weights of the salt taken were 0·1985, 0·4480, 0·3405, and 0·4641 grm. respectively; the number of c.c. of peroxide taken were 5·73, 12·44, 9·86, and 13·16. The amounts of hydrogen peroxide required for 1 grm. of the iron salt were found, therefore, to be 28·86, 27·77, 28·96, and 28·36 c.c. As ammonium sulphate is stated to make the reaction between permanganate and oxalic acid take place more smoothly and much more rapidly, it was thought that possibly the much greater irregularities observed in these results than in those with the standard solution were due to the presence of excess of ammonium sulphate in the latter. Seven portions of the Mohr's salt were again weighed out, about an equal amount of solid ammonium sulphate added, and the remainder of the operation carried out as before, except that the solution of hydrogen peroxide used was somewhat more concentrated, about 0·15 N. The following are the data obtained:—

| No. | Salt taken. | Peroxide required. | C.c. of peroxide required per grm. of salt |
|---|---|---|---|
| | Grm | C.c. | |
| 1 .. | 0·1902 | 3·09 | 16·24 |
| 2 .. | 0·3420 | 5·54 | 16·19 |
| 3 .. | 0·4918 | 7·90 | 16·07 |
| 4 .. | 0·5374 | 8·74 | 16·26 |
| 5 .. | 0·6258 | 10·11 | 16·15 |
| 6 .. | 1·1133 | 17·82 | 16·01 |
| 7 .. | 1·4645 | 23·45 | 16·01 |

These results indicate that ferrous iron can be accurately estimated with standard hydrogen peroxide if the titre of the latter be fixed with a known amount of the same substance.

Three weighed portions of the salt were titrated against a peroxide solution, and from the mean the normality of the latter was calculated. The normality was also determined by titration against a carefully standardised permanganate solution. As the effect of slight overstepping of the end-point necessary to give the liquid a tinge of colour to make the normality appear too high in the permanganate-peroxide solution, but too low in that of the iron against the peroxide, considerable care was taken to minimise this error. The titrations were made carefully, and the reaction considered complete when the solution showed just a sufficient tinge of colour to be recognised with certainty. The following are the data:—

*Titration of Peroxide against Ferrous Ammonium Sulphate.*

| No. | Salt taken. | Peroxide required. | C.c. of peroxide required per grm. of salt. |
|---|---|---|---|
| | Grm. | C.c. | |
| 1 .. | 0·6771 | 11·54 | 17·04 |
| 2 .. | 0·5631 | 9·66 | 17·15 |
| 3 .. | 0·9563 | 16·23 | 17·02 |

Normality of $H_2O_2$ solution = 0·1498.

*Titration of Peroxide against Permanganate.*

10 c.c. $H_2O_2$ solution = 13·37 c.c. $KMnO_4$ solution.
25 c.c. $H_2O_2$ solution = 33·35 c.c. $KMnO_4$ solution:
Normality of $H_2O_2$ solution = 0·1507.

The agreement is satisfactory considering the strengths of the solutions and the quantities used. As the hydrogen peroxide solution had been prepared by diluting the ordinary pharmaceutical preparation, the slightly higher value obtained with the permanganate may have been due to the presence of traces of foreign matter. As C. E. Smith has shown (Chemical News, lxxx., 204), commercial hydrogen peroxide sometimes yields too high results when titrated against potassium permanganate because of the presence of organic substances. Small amounts of these would probably be without influence on the results obtained with ferrous sulphate.

The above indicates a simple method for determining the strength of samples of hydrogen peroxide. The solution is diluted with a known amount of water, so that its strength is reduced to about 0·2 N (0·3 per cent). About 2 grms. of ferrous ammonium sulphate are weighed out, dissolved in a little water, and a few grms. of ammonium sulphate and some phosphoric acid added. Some of the titanium solution is then poured in and the mixture titrated against the peroxide, the latter being added from a burette.

*Sodium Nitrite.*—In these experiments solutions of sodium nitrite of about 0·5 N or 0·2 N were used. As by the action of the acid present in the indicator there is a slight loss of nitrous acid when it is first added to the solution, a rough preliminary titration was made to determine the approximate amount of hydrogen peroxide required; then, in the subsequent titration, almost this amount was added, the indicator poured in, and the titration finished. The results obtained, while reasonably concordant, have been uniformly slightly too high. This is probably due, to some extent at least, to the fact that the reaction is quite slow near the end-point. Probably reasonably accurate results can be obtained only when the titre of the peroxide is fixed with a known amount of nitrite.

Work is being continued in this laboratory with a view to testing the application of the above method to the estimation of certain organic compounds, readily oxidised by hydrogen peroxide in acid or in alkaline solutions.

Grateful acknowledgment is hereby made to Prof. J. T. Willard, through whose kindness these tests have been made.—*American Chemical Journal*, xxxvi., No. 2.

## THE ATOMIC WEIGHT OF NITROGEN.

In the last report, for 1906, of the International Committee on Atomic Weights, attention is called to recent work on chlorine and nitrogen which indicates that an entire revision of the atomic weights may soon be necessary, because nearly all of them are based on the assumed accuracy of a few, such as those of silver, chlorine, bromine, sodium, &c., some of which have been changed as a result of the use of improved and more accurate methods. In the report, reference also is made to the fact that nearly all the weights are based on the analyses of several oxyhalogen salts. "Their accuracy is assumed, and all the anomalies which appear in determinations based upon other lines of research are commonly ascribed to undiscovered errors. The assumption may be sustained, but it is not yet beyond the reach of criticism." Among the atomic weights which have been re-determined by the more accurate and logical methods is that of nitrogen. The results obtained by independent workers, using different substances and both gravimetric and volumetric methods, necessitate the acceptance of the value 14·01 instead of the value 14·04 as found by the indirect gravimetric methods, and as adopted by the International Committee on Atomic Weights. This work upon the atomic weight of nitrogen has been carried out by Guye (*Bull. Soc. Chim.*, 1905, [3], xxxiii., 44) and his colleagues at Geneva, and by Gray (*Journ. Chem. Soc.* 1905, lxxxvii., 1601) in Sir William Ramsay's laboratory

and in the Chemical Institute in Bonn. The basis of the present report is a lecture on the subject delivered by Guye last year before the Chemical Society of Paris. The fact is pointed out that, in the methods used by Stas and his predecessors and followers, as shown in Table I., the values are not very concordant, and are generally higher than the values in Table II., which are based upon determinations of the densities of the gases, corrected by physical-chemical methods.

TABLE I.—*From Chemical Data.*

| | | Ratio. | Atomic weight. |
|---|---|---|---|
| 1843 | Marignac .. .. .. | | 14·043 |
| 1865 | Stas .. .. .. .. | | 14·055 |
| 1900 | Dean .. .. .. .. | $AgCN : Ag$ | 14·031 |
| 1901 | Scott .. .. .. .. | | 14·010 |
| 1894 | Thomsen .. .. .. | $HCl : NH_3$ | 14·021 |
| 1896 | Hardin .. .. .. .. | $Ag : AgNO_3$ | 14·01 |
| 1904 | Richards and Archibald | $CsNO_3 : CsO_4$ | 14·037 |
| | | $KNO_3 : K_2O_4$ | 14·040 |

TABLE II.—*From Physical Data.*

| | | Gases compared. | Method of correction. | Atomic weight. |
|---|---|---|---|---|
| 1905 | Rayleigh .. | $N_2$ and $O_2$ | Limiting densities. | 14·009 |
| | | $N_2O$ „ $O_2$ | Limiting densities. | 13·996 |
| 1898 | Berthelot .. | $N_2$ „ $O_2$ | Limiting densities. | 14·007 |
| 1897 | Leduc .... | $N_2$ „ $O_2$ | Molecular volumes | 14·005 |
| 1905 | Jaquerod and Perrot... | $N_2$ „ $O_2$ | Comparison at high temperatures .. | 14·008 |

Guye points out that the methods which have been used in determining the atomic weight of nitrogen gravimetrically introduce a number of uncertain factors, and increase the probable error of the result. Thus, in the case when the value is determined from a study of the ratio $Ag : NH_4Cl$, he shows that the atomic weight determined can be expressed by the equation $X = Ar - B$; when $r$ is the ratio of the silver and ammonium chloride, A the assumed known atomic weight of silver, and B the sum of the atomic weights of $4H + Cl$. While the value for $r$ can be determined with considerable accuracy, those for A and B involve greater errors, especially as nearly all of the atomic weights are based on that of silver, and an error here would produce a greater error in the atomic weights of the other substances whose weights have been determined by reference to it. Guye concludes that the errors in the atomic weight of nitrogen, as determined by the classical methods of Stas and his predecessors and followers, vary from $\pm 0{\cdot}013$ to $\pm 0{\cdot}039$, and that these methods cannot be used to determine the atomic weight of nitrogen with accuracy in the second decimal place.

On the other hand, by the use of modern physical chemical methods, very concordant and accurate determinations can be made. These values are obtained by determining the ratio of the density of nitrogen to that of other gases, the results being then corrected with due regard to the laws of Boyle, Avogadro, &c. The methods used to correct the densities found are :—

*a*. The reduction of the critical constants;
*b*. The method of limiting densities;
*c*. The method of corresponding densities;
*d*. The method of the molecular volumes.

In this manner results are obtained in which the error is only $\pm 0{\cdot}003$.

The atomic weight of nitrogen as determined by these methods is 14·008, as shown by the following summary of the results :—

| | | | |
|---|---|---|---|
| Ratio of | $N_2$ and $O_2$ | (six determinations) . .. | 14·009 |
| „ | $N_2$ „ $CO$ | (six determinations) . .. | 14·006 |
| „ | $N_2O$ „ $CO_2$ | (two determinations) .. | 14·007 |
| „ | $NO$ „ $O_2$ | (two determinations) .. | 14·008 |
| | | General average .. | 14·008 |

While the older gravimetric methods used to determine the atomic weight of nitrogen are not accurate, owing largely to their unfortunate selection, it is possible to choose substances where both the direct weights and volume relations can be determined in the same substance.

Guye has thus been able, using nitrous oxide, to determine the atomic weight of nitrogen by the two methods. A glass tube, containing a spiral of iron wire, connected by platinum loops fused in the ends of the tube, is first exhausted and weighed, then filled with pure dry nitrous oxide and weighed. If a current is then passed through the spiral the gas is decomposed and the nitrogen formed is absorbed in a tube of cocoanut charcoal which has been carefully exhausted. The weight of the nitrogen can thus be determined, as can that of the oxygen, by the increase of weight of the tube containing the spiral. This, of course, is a very brief outline of the method and gives no idea of the immense difficulties which had to be overcome before it could be used. The average of one series of five determinations was 14·007, while another, of three determinations, gave 14·004.

In the analysis by volume the same apparatus was used to decompose the gas. The vessel, to which a manometer was attached, was filled with nitrous oxide, which, after its pressure had been determined, was decomposed. By observing the change in pressure, keeping the volume constant, the necessary data could be obtained from which to calculate the atomic weight. The mean of four determinations by this method gave 14·015, which, averaged with the analyses by weight, gives a mean of 14·009, as compared with the atomic weight 14·008 by the physical-chemical method.

| | |
|---|---|
| Analysis by weight of $N_2O$ (five determinations) .. | 14·007 |
| Analysis by weight of $N_2O$ (three determinations). | 14·003 |
| Analysis by volume of $N_2O$ (six determinations) .. | 14·015 |
| | 14·009 |

That this figure, or, in round numbers, 14·01, is more correct than 14·04 is confirmed by the work of Gray, who used nitric oxide, which was obtained free from nitrous oxide and nitrogen. The nitrous oxide was removed by allowing the impure nitric oxide gas to bubble through several vessels containing liquid nitric oxide in which the nitrous oxide was absorbed. The nitrogen was separated by subliming the nitric oxide containing nitrogen at a low pressure and removing the nitrogen, which was not absorbed under these conditions, by the pump. The gas thus obtained was carefully tested for impurities, its density was determined, and the value corrected to reduce it to that which it would have as a perfect gas, and also to obtain the atomic weight of nitrogen by the gravimetric method. The apparatus used by Gray consisted of a vessel which could be exhausted; it contained a porcelain boat resting upon nickel supports; these served as the two poles of a source of electricity which was used to heat the contents of the boat by means of a platinum wire wound around the boat and connected with the nickel wires. Carefully purified nickel, in a finely divided condition, was placed in the boat. The known weight of nitric oxide could be decomposed by contact with the heated nickel, the free nitrogen absorbed in charcoal and weighed, and the oxygen determined by the increase in weight of the bulb and boat.

The results obtained by this method may be summarised in the following table :—

| | |
|---|---|
| I. From the density of nitric oxide corrected by two different methods, twelve results .. .. | 14·006 |
| II. From the density of nitrogen gas obtained in the gravimetric analysis, two results .. .. | 14·008 |
| III. From the gravimetric analysis of nitric oxide, twenty-two results .. .. .. .. .. .. .. | 14·010 |
| General average, giving each result an equal value .. .. .. .. .. .. .. .. .. .. | 14·0085 |

From an examination of Tables I. and II. it will be seen that the physical-chemical methods give, in general, more concordant and lower results than the chemical methods. Guye suggests that possibly this may be due to an error in the atomic weight of silver, and presents the following arguments in favour of a lower value:—

Re-calculating sixty determinations of the ratio of silver to silver salts, using the figure 14·01 for nitrogen, the average result for silver is 107·885.

While the atomic weights of carbon, nitrogen, and hydrogen have been accurately determined by the physical-chemical methods, those of chlorine, sulphur, and phosphorus have been obtained by the use of only one gas in each case, and the results have not yet been verified. If these weights are used to re-calculate a number of determinations, an average of 107·905 is obtained for silver.

Dixon and Edgar have determined the atomic weight of chlorine by a direct synthesis of hydrochloric acid, from hydrogen and chlorine; they obtain the value 35·463. The use of this weight in the re-calculation of the atomic weight of silver gives the figure 107·88.

From a consideration of all these facts Guye suggests that the difference in the atomic weight of nitrogen, as obtained by the older gravimetric methods and by the physical-chemical methods, may be due to the use of too high an atomic weight for silver, which probably lies between 107·871 and 107·895, and cannot be as high as 107·93, the value adopted by the Committee on Atomic Weights.—*American Chemical Journal*, xxxv., No. 5.

## PROCEEDINGS OF SOCIETIES.

### CHEMICAL SOCIETY.

The following are abstracts of papers received during the vacation, and published or passed for publication in the *Transactions*:—

151. "*Some New Derivatives of Dicyclopentadiene.*" By Alexander Rule.

The author has prepared a *nitrosobromide* of di*cyclo*pentadiene similar to the nitrosochloride described by Kraemer and Spilker, and also the corresponding derivatives of mono*cyclo*pentadiene. Attempts were made to prepare oxime derivatives, but the yields in each case were poor.

By treating the nitrosobromide with alcoholic sodium ethoxide, an *ethoxy*iso*nitroso*-derivative was obtained, whilst the *oxynitroso*-derivative itself was prepared by treating the pyridinium compound of the nitrosochloride with moist silver oxide.

In neither case was it possible to obtain a ketone by further reactions, owing to the instability of the substances.

The piperidine base prepared from the nitrosochloride is a well-characterised derivative, and forms a sparingly soluble *hydrochloride*. On reduction with sodium in alcoholic solution it is partially converted into a *diamine* base, which forms an easily soluble *hydrochloride* and a crystalline *platinichloride*.

152. "*Some Derivatives of 2- and 3-Phenanthrol.*" By Herbert Henstock.

2-Phenanthryl ethyl ether was nitrated by adding nitric acid to its solution in glacial acetic acid, and the *nitro*-derivative yielded an *amino*-compound with tin and hydrochloric acid. When this was treated with nitrous acid, the *diazo*-compound, $OEt{\cdot}C_{14}H_8{\cdot}N_2{\cdot}SO_4Na,6H_2O$, was obtained.

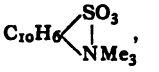
The nitro-compound of the 3-ethyl ether similarly yielded an *amino*-derivative which can be diazotised.

The 3-nitro-compound, on heating with dry bromine under pressure, gave a 2:7-*dibromo*-derivative. By oxidation of the 3-ethyl ether with chromium trioxide a phenanthraquinone was obtained which, on treatment with hydroxylamine hydrochloride, yielded a *monoxime*.

153. "*Steric Hindrance in the Naphthalene Series.*" By Clarence Smith.

Sodium β-naphthylamine-8-sulphonate forms diazoamines with benzene- and *p*-toluene-diazonium chlorides, both being yellow crystalline substances; the former melts and decomposes at 224°, the latter at 219°.

*Potassium dimethyl-β-naphthylamine-8-sulphonate*, $SO_3K{\cdot}C_{10}H_6{\cdot}NMe_2$, obtained from dimethyl sulphate and β-naphthylamine-8-sulphonic acid in alkaline solution, forms colourless crystals easily soluble in water or alcohol. An intermediate product in the preparation, probably *anhydrotrimethylaminonaphthalenesulphonic acid*,—



is an exceedingly deliquescent, colourless, crystalline substance, soluble in water, insoluble in organic solvents, but has not yet been obtained in the pure state.

The *acid*, $SO_3H{\cdot}C_{10}H_6{\cdot}NMe_2$, forms colourless needles, is sparingly soluble in cold water, dissolves readily in hot water or alcohol, forming solutions with a fine blue fluorescence, and does not react with diazonium salts.

p-*Tolylazo*-8 *nitro-β-naphthylamine*,—

$$C_7H_7N_2{\cdot}C_{10}H_5(NO_2)NH_2,$$

forms reddish brown crystals with a green reflex, and melts at 253°.

The influence of steric hindrance is very obvious when the rates are compared at which "G" and "R" salts respectively combine with *p*-toluenediazonium chloride. With approximately one-twentieth molecular solutions, the reaction was complete within five minutes in the latter case, whereas in the former, after fourteen hours, 39 per cent of the diazonium salt, estimated as *p*-tolylazo-β-naphthol, was still uncombined. With a one-fiftieth molecular solution of "G" or "R" salt, after twenty-four hours the amounts of free diazonium salt were 31·0 and 0 per cent respectively.

*Sodium 1-bromo-β-naphthol-8-sulphonate*,—

$$SO_3Na{\cdot}C_{10}H_5Br(OH),3H_2O,$$

obtained from bromine and sodium β-naphthol-8-sulphonate in aqueous solutions, forms colourless glistening leaflets; the halogen is not displaced by diazo-complexes.

154. "*Electrolytic Reduction. I. Aromatic Aldehydes.*" By Herbert Drake Law.

By the electrolytic reduction of aromatic aldehydes, compounds of the hydrobenzoin type were obtained, the reaction proceeding according to the equation $2X{\cdot}CHO + 2H = X{\cdot}CH(OH){\cdot}CH(OH){\cdot}X$. Such substituted groups as —OH, —$OCH_3$, $=O_2{:}CH_2$, exercise no influence whatever on this reaction; thus vanillin, salicylaldehyde, and piperonal yielded compounds of the above type. Ketones, however, do not show this regularity, the substance formed being contaminated with further reduction products.

155. "*Electrolytic Reduction. II. Use of Electrodes.*" By Herbert Drake Law.

The velocity of a chemical reaction at the electrodes in an electrolytic experiment is regulated by the rate of diffusion of the solute, and may be represented by the following differential equation:—

$$\frac{dc}{dt} = K(C - C'),$$

C and C′ being the concentrations before and after the experiment. Where C′ is small, then by substitution of the hydrogen equivalent for C the following equation results:—

$$\frac{1}{Hc} \log \frac{H}{H - h} = K.$$

H represents the hydrogen absorbed at any time, H*c* the total hydrogen required, and *h* the amount already used. When C′ is small, the velocity is almost independent of

the potential of the hydrogen, but otherwise this factor must be taken into account. Further, we have $C - C' \propto 2C' \times P_H$, where $P_H$ is the potential factor (*Analyst*, 1906, xxxi., 3). This, introduced into the above equations, represents the complete action in the absence of catalytic agents.

156. "*Studies on Optically Active Carbimides.* Part IV. *The Resolution of* ac-*Tetrahydro-2-naphthol by means of* l-*Menthylcarbimide.*" By ROBERT HOWSON PICKARD and WILLIAM OSWALD LITTLEBURY.

*ac*-Tetrahydro-2-naphthol has been resolved in a similar manner to α-phenyl-α'-4-hydroxyphenylethane (*Proc.*, xxii., 71).

d-*ac-Tetrahydro-2-naphthol* l-*menthylcarbamate*, separated from the corresponding (*ll*) *carbamate* by fractional crystallisation from alcohol, melts at 131°, and has $[\alpha]_D$ −33·4° in chloroform.

d-*ac-Tetrahydro-2-naphthol* is a pale yellow oil, which has $[\alpha]_D$ +28·2° in chloroform and $[\alpha]_D$ +27·6° in benzene. The *phenylcarbamate* melts at 115—117°, and has $[\alpha]_D$ +25·2° in chloroform.

157. "*Tetrazoline.*" (Part IV.). By SIEGFRIED RUHEMANN.

The author showed that the compounds $C_5H_{11}N_4I$ and $C_5H_{11}N_4I_3$, which C-dimethyltetrazoline,—

$$CH_3{\cdot}C\begin{matrix}=N{\cdot}NH\\ NH{\cdot}N=\end{matrix}C{\cdot}CH_3,$$

forms with methyl iodide, have properties unlike the corresponding substances $C_3H_7N_4I$ and $C_3H_7N_4I_3$, which are obtained from tetrazoline (Ruhemann and Merriman, *Trans.*, 1905, lxxxvii., 1768). A difference between tetrazoline and C-dimethyltetrazoline has also been observed with regard to the condensation products which these bases yield with aldehydes. The substance which is formed from salicylaldehyde and C-dimethyltetrazoline has the composition $C_{11}H_{12}ON_4,H_2O$; it therefore contains one molecule of water, which it losses at 100°, and its solution in dilute hydrochloric acid does not give a precipitate with platinic chloride. These properties differ from those of salicylidene tetrazoline and its analogues (*loc. cit.*). On account of these facts the author adheres to the view that the condensation products of aldehydes with tetrazoline are to be represented thus, $R{\cdot}CH{:}C\begin{matrix}N=N\\ NH{\cdot}N=\end{matrix}CH$.

Bisdiazomethane, $CH_2\begin{matrix}N{:}N\\ N{:}N\end{matrix}CH_2$, condenses with only one molecule of an aldehyde to form compounds of the formula $R{\cdot}CH{:}C\begin{matrix}N{:}N\\ N{:}N\end{matrix}CH_2$, which are readily hydrolysed. Their solutions in dilute hydrochloric acid do not yield precipitates with platinic chloride.

158. "*Labile Isomerism among Acyl Derivatives of Salicylamide.*" By JAMES MCCONNAN and ARTHUR WALSH TITHERLEY.

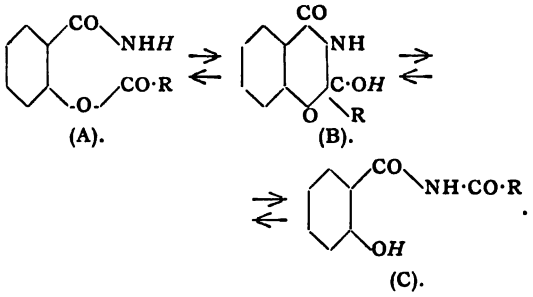
The authors have made a further study of the constitution of Gerhardt's benzoylsalicylamide, which is a tautomeric substance behaving both as *N*-benzoylsalicyl amide and the cyclic metoxazone derivative,—

$$C_6H_4\begin{matrix}CO{\cdot}NH\\ |\\ O{-}C(OH)Ph\end{matrix}.$$

In general, acyl derivatives of salicylamide show remarkable labile characters, and the changes which they undergo may be expressed by the scheme shown in next column.

The possibility of individual existence of *N*-acylsalicylamides apparently depends on the nature of R, and, in general, varying degrees of stability of the types A, B, and C appear, according to the nature of this group, and according to whether the residual hydrogen atom of the NH group is further replaced.

In the case of O-*acetylsalicylamide* (m. p. 138°, which readily re-arranges, the intermediate metoxazone derivative is too unstable to exist, and N-*acetylsalicylamide* (m. p. 147°) results. *O*-Benzoyl-*N*-acetylsalicylamide




(m. p. 96°) passes with extreme ease into N-*acetyl*-2 : 2-*phenylhydroxybenzometoxazone* (m. p. 106°), which readily reverts to the open-chain isomeride (m. p. 96°). O-*Acetyl*-N-*benzoylsalicylamide* (m. p. 124°) re-arranges less readily than its isomeride melting at 96°, yielding, however, the same metoxazone derivatives. *NN*-Diacyl salicylamides, $C_6H_4\begin{matrix}CO{\cdot}N(CO{\cdot}R)_2\\ OH\end{matrix}$, are apparently too unstable to exist, the tendency to re-arrange being so great that the isomeric metoxazone derivative,—

$$C_6H_4\begin{matrix}CO{\cdot}N{\cdot}CO{\cdot}R\\ |\\ O{-}C(OH)R\end{matrix},$$

is formed, which in its turn may re-arrange, yielding the open-chain derivative, $C_6H_4\begin{matrix}CO{\cdot}NH{\cdot}CO{\cdot}R\\ O{\cdot}CO{\cdot}R\end{matrix}$.

159. "*The Action of Nitrous Acid on the Arylsulphonylmetadiamines.*" By GILBERT THOMAS MORGAN and FRANCES MARY GORE MICKLETHWAIT (with E. G. COUZENS).

The arylsulphonyl derivatives of the ortho- and para-diamines having been shown to yield characteristic diazoimides on treatment with nitrous acid, a series of the arylsulphonylmetadiamines, $R{\cdot}SO_2{\cdot}NH{\cdot}X{\cdot}NH_2$, was examined in order to ascertain whether their diazonium chlorides, $R{\cdot}SO_2{\cdot}NH{\cdot}X{\cdot}N_2Cl$, would give rise to diazoimides. The monobenzenesulphonyl derivatives of tolylene-2 : 4-diamine, 4 : 6-diamino-*m*-xylene, and diaminomesitylene were prepared and subjected to the action of nitrous acid in hydrochloric acid solution; their diazonium chlorides, which were stable in acid solution or in the dry state, underwent decomposition at the ordinary temperature on treatment with sodium acetate, evolving at least 50 per cent, and in some cases even the whole of the diazo-nitrogen, and leaving either arylsulphonylaminophenols or ill-defined azo-derivatives or mixtures of these substances. In no case could any diazoimide be detected.

160. "*Dinaphthacridines.*" By ALFRED SENIER and PERCY CORLETT AUSTIN.

The authors have made a further study of the interaction of methylene di-iodide on naphthylamines, which was introduced by one of them and Goodwin in 1902 as a general method of acridine synthesis. They have also found the requisite conditions for the substitution of methylene dichloride for the di-iodide and of its analogues, ethylidene chloride and benzal chloride, in the synthesis of dinaphthacridines, which renders the preparation of the $\begin{matrix}\alpha\text{-}N\text{-}\alpha\\ |\\ \beta\text{-}CH\text{-}\beta\end{matrix}$ dinaphthacridine much easier.

The notation employed is that proposed by Senier (*Brit. Assoc. Report*, 1903, 616: CHEMICAL NEWS, 1903, lxxxviii., 272).

When methylene dichloride and α-naphthylamine were heated in a closed tube at 230°, $\begin{matrix}\alpha\text{-}N\text{-}\alpha\\ |\\ \beta\text{-}CH\text{-}\beta\end{matrix}$ dinaphthacridine was formed. It distils unchanged, melts at 185·5 (189° corr.), not at 173° as previously stated, exhibits triboluminescence, and yields an *aurichloride*.

α-N-β
| Dinaphthacridine, prepared by the methylene
β-CH-α
dichloride and other new methods, distils unchanged, is not triboluminescent, melts at 223° (228° corr.), and forms a *platinichloride* and *bisdinaphthacridine hexabromide*.

β-N-β
| Dinaphthacridine (β-naphthacridine, Reed) was
α-CH-α
prepared by the action of methylene dichloride on β-naphthylamine in a closed tube. It is not triboluminescent. Using methylene di-iodide, it was found that, by varying the conditions of the experiment, (1) Reed's base alone, (2) Morgan's base chiefly, or (3) a mixture of the two, could be obtained.

α-N-α
| *Methyldinaphthacridine*, obtained from ethyl-
β-CMe-β
idene chloride and α-naphthylamine, forms greenish yellow octahedra melting at 219° (224° corr.), which are not triboluminescent.

The *hydrochloride*, *aurichloride*, *platinichloride*, and *dibromide* were described.

α-N-α
| *Phenyldinaphthacridine*, prepared from benzal
β-CPh-β
chloride and α-naphthylamine in presence of naphthalene, forms yellow hexagonal plates, which are not triboluminescent, and melt at 224° (229° corr.). It yields a *hydrochloride*, *platinichloride*, and *aurichloride*.

β-N-β
| Phenyldinaphthacridine was prepared from
α-CPh-α
benzal chloride and β-napthylamine. It is not triboluminescent, and melts at 293° (301·5° corr.).

161. "*The Relation of Position Isomerism to Optical Activity.* VII. *The Rotation of the Menthyl Esters of three Isomeric Dinitrobenzoic Acids.*" By Julius Berend Cohen and Henry Percy Armes.

The menthyl esters selected for investigation were those of the 2 : 4-, 2 : 6-, and 3 : 5-dinitrobenzoic acids. In a previous communication on this subject (*Trans.*, 1905, lxxxvii., 122) it was shown that of the three mononitro-esters the ortho-compound produced the greatest rotation and the para- the least, the meta-ester lying between the two. The present results agree with the former observations. The di-ortho-compound has the highest molecular rotation, $[M]_D$ -642°, and the di-meta- the lowest, $[M]_D$ -246°, whilst the compound which contains one nitro-group in the ortho- and one in the para-position has a constant which is nearly the mean of the other two, namely, $[M]_D$ -470°. At the conclusion of the paper, one of the authors draws attention to the evidences of steric hindrance which are afforded by the action of di-ortho-substituted acid chlorides on menthol.

162. "*The Properties of* 2 : 3 : 4 : 5-*Tetrachlorotoluene.*" (A correction). By Julius Berend Cohen and Henry Drysdale Dakin.

In a paper on the chlorination of the trichlorotoluenes (*Trans.*, 1904, lxxxv., 1274) it was stated that whereas 3 : 4 : 5-trichlorotoluene was converted on chlorination into a tetrachlorotoluene (m. p. 97—98°) which gave a nitro-derivative melting at 159°, 2 : 3 : 4 : 5-tetrachlorotoluene from 2 : 4 : 5-trichloronitrotoluene melted at 86—88°, and gave a nitro-derivative having the same melting-point. It is now found that the latter observation is incorrect, and that the tetrachlorotoluene obtained from 2 : 4 : 5-trichloronitrotoluene is identical with that prepared by the chlorination of 3 : 4 : 5-trichlorotoluene.

163. "*A Method for the Formation of Succinic Acid and of its Alkyl Derivatives.*" By Annie Higson and Jocelyn Field Thorpe.

The cyanohydrins of aldehydes and ketones readily react in the cold with the sodium derivative of ethyl cyanoacetate, forming the sodium derivatives of dicyano-ethyl salts in accordance with the general equation :—

$$CO_2Et{\cdot}C(CN)NaH + HO{\cdot}C(CN)RR' = CO_2Et{\cdot}C(CN)Na{\cdot}C(CN)RR' + H_2O.$$

The free ethyl salts can be prepared from these sodium derivatives on treatment with acids, and on hydrolysis may be converted into the corresponding derivatives of succinic acid.

The following cyanohydrins have been investigated :—

Formaldehydecyanohydrin, giving succinic acid ;
Lactic nitrile, giving methylsuccinic acid ;
Acetonecyanohydrin, giving *asym*-dimethylsuccinic acid ;
Methylethylketonecyanohydrin, giving methylethylsuccinic acid ;
Œnantholcyanohydrin, giving hexylsuccinic acid ;
Mandelic nitrile, giving phenylsuccinic acid.

It is further pointed out that the sodium compound which is formed in the condensation may be treated directly with an alkyl iodide, and in this way further alkylated derivatives of succinic acid can be prepared. For example, *cis*- and *trans*-dimethylsuccinic acids were obtained from lactic nitrile and trimethylsuccinic acid from acetonecyanohydrin, in each case by treating the sodium compound formed in the condensation of these cyanohydrins and ethyl sodiocyanoacetate with methyl iodide and hydrolysing the product.

164. "*The Gum of* Cochlospermum Gossypium." By Henry Haliburton Robinson.

A small tree, *Cochlospermum Gossypium*, yields a gum which resembles tragacanth in absorbing a large quantity of water, and swelling up to many times its original size ; it is also remarkable for its property of slowly giving off acetic acid.

By hydrolysing the gum with dilute sulphuric acid, a dibasic acid of the formula $C_{23}H_{36}O_{21}$ was obtained, for which the name *gondic acid* is proposed. Gondic acid is soluble in water, and is precipitated from its aqueous solution by alcohol as a white amorphous substance ; by evaporation it is obtained in colourless transparent flakes. Like gum arabic, it gives a solution having adhesive power. When dried at 100°, 100 parts of the acid neutralise 23·7 parts of barium oxide, and the rotatory power is $[\alpha]_D$ +97·7° ; it forms salts by addition and not by replacement ; thus, the barium salt is $C_{23}H_{36}O_{21},BaO$.

From the liquids from which the gondic acid had been separated, two sugars were obtained ; one of these was xylose and the other was a hexose, possibly galactose, although it presented some differences.

The original gum yielded 14 per cent of acetic acid. By prolonged treatment with cold sodium hydroxide solution and then acidifying and dialysing, a clear, viscid, colloid solution was obtained containing a de-acetylated product, which can be precipitated by alcohol in presence of hydrochloric acid. This substance, for which the name *α-cochlosperminic acid* is proposed, gelatinises with water, but does not dissolve.

165. "*Studies in the Acridine Series.* Part IV. *The Methylation of Chrysophenol.*" By Albert Ernest Dunstan and John Theodore Hewitt.

In previous communications, anhydro-bases have been described resulting from the acetylation of 2-amino-3 : 7-dimethylacridine, benzoflavine, and chrysaniline, conversion into quaternary ammonium compounds, and subsequent removal of the acetyl groups (*Trans.*, 1904, lxxxv., 529 ; 1905, lxxxvii., 1058 ; and 1906, lxxxix., 482). Fischer and Körner (*Ber.*, 1884, xvii., 203 ; *Annalen*, 1886, ccxxvi., 175) examined the chrysophenol which Claus had produced by heating chrysaniline with hydrochloric acid under pressure. The present authors conclude that it is the amino-group in the acridine nucleus which is displaced by hydroxyl, and regard chrysophenol as 2-hydroxy-5-*p*-aminophenylacridine.

This base gave a *diacetyl* derivative which, when treated with dimethyl sulphate, yielded a quaternary ammonium salt. On removal of the acetyl groups, salts of a base were obtained which, when first liberated, is soluble in excess of alkali as well as of acid. This is probably 2-*hydroxy*-5-p-*aminophenyl*-10-*methylacridanol*-5; on drying at 100° it gave an *anhydro*-base, $C_{20}H_{16}ON_2$. Various derivatives of chrysophenol, the *acetyl* compound, and the *base* $C_{20}H_{16}ON_2$ were described, and the solutions of the different substances have been examined with regard to fluorescence.

166. "*Optically Active reduced Naphthoic Acids.* Part III. *The Relative Catalytic effect of Bases on the Compounds of* $\Delta^2$-*Dihydro*-1-*naphthoic Acid.*" By ROBERT HOWSON PICKARD and JOSEPH YATES.

Sodium *d*-$\Delta^2$-dihydro-1-naphthoate is transformed in aqueous solution in the presence of hydroxyl ions to the salt of the corresponding $\Delta^1$-acid. The "strengths" of various inorganic and organic bases as regards this specific reagent have been compared and found to correspond roughly with those deduced from the electrical conductivities. The influence of sodium chloride on the velocity of the transformation is very similar to its influence on the velocity of the catalytic hydrolysis of methyl acetate. There is no difference in the rate of transformation of the sodium salts of the dextro- and lævo-acids.

The methyl ester of the *d*-$\Delta^2$-acid is transformed in the presence of an organic base in an anhydrous organic solvent with a much greater velocity than the transformation of the sodium salt in water.

The methanism of the two transformations is probably different, the ester being transformed in the presence of a tertiary base.

167. "*Estimation of Copper by Titanium Trichloride.*" By EZRA LOBB RHEAD.

Copper may be quickly and accurately estimated by means of a standard solution of titanium trichloride in presence of potassium thiocyanate.

Cupric salts are reduced and the copper precipitated as cuprous thiocyanate in presence of either sulphuric or hydrochloric acid. The end of the reaction may be rendered more distinct by adding a ferrous salt, either mixed with the standard solution or separately. Cupric salts oxidise ferrous salts, and a red colour is produced with the thiocyanate present; its discharge marks the end of the reaction, which is perfectly sharp.

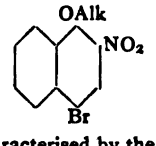
The titration is conducted below 30°, and the whole of the reagent added as quickly as possible.

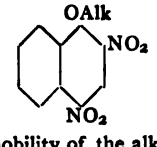
Ferric and cupric salts may be estimated together, and the amount of iron deducted after being separately determined.

The new method is as accurate as the electrolytic and iodometric methods, and free from the objections and difficulties attaching to them.

168. "*Notes on Derivatives of* α-N-*Alkylated Naphthylamine.*" By RAPHAEL MELDOLA.

Naphthalene derivatives of the types—




are characterised by the extreme mobility of the alkyloxy-group, which is readily exchanged for the alkylamino-group when the compounds in question are treated in alcoholic solution with amines of the type $R{\cdot}CH_2{\cdot}NH_2$. By this means, 2 : 4-*dinitro*-α-*ethylnaphthylamine* (m. p. 169—170°) and 4-*bromo*-2-*nitro*-α-*benzylnaphthylamine* (m. p. 126—127°) and some of their derivatives have been prepared.

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The following note has been received during the vacation :—

169. "*Note on a Compound of Thiocarbamide and Potassium Iodide.*" By EMIL ALPHONSE WERNER.

While studying the interaction of iodine and thiocarbamide in aqueous solution, the author incidentally obtained *tetra - thiocarbamide potassium iodide*, $(CSN_2H_4)_4KI$, analogous to the tetra-thiocarbamide ammonium bromide, $(CSN_2H_4)_4{\cdot}NH_4Br$, prepared and described by Emerson Reynolds (*Trans.*, 1891, lix., 385). It is formed quantitatively when hot solutions of the separate substances in absolute alcohol are mixed; the new compound crystallises as the liquid cools, in long, delicate, interlacing needles melting at 189—190° and possessing a beautiful satiny lustre, resembling the ammonium bromide compound.

0·3 distilled with an excess of ferric sulphate solution gave 0·08108 iodine; I = 27·03. $C_4H_{16}N_8IS_4K$ requires I = 27·02 per cent.

The substance is dissociated in dilute aqueous solution, but may be crystallised from a very concentrated solution without sensible decomposition.

All attempts to prepare an analogous, or indeed any compound, from thiocarbamide and sodium iodide were unsuccessful, such a sharp difference in the behaviour of the potassium and sodium salts being rather remarkable.

The compound with ammonium iodide (m. p. 186°) has already been prepared. Potassium bromide and thiocarbamide combine only with difficulty.

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## NOTICES OF BOOKS.

*Modern Soaps, Candles, and Glycerin.* By LEEBERT LLOYD LAMBORN. New York: D. Van Nostrand Company. London: Crosby Lockwood and Son. 1906.

THIS book will be found more useful to the manufacturer than to the chemist, to supply the former's need of an essentially practical work having been the author's special aim, although a certain amount of theory is necessarily introduced. The mechanical equipment of factories, their general construction and location, are discussed in it, and the problems in engineering which are met with in soap manufacture are treated as fully as space will allow, the subject being regarded almost exclusively from the point of view of the American manufacturer; for instance, in the tables of equivalent prices for soda-ash and for caustic soda, the cost per 100 lbs., &c., is always given in dollars, and most of the illustrations are those of pieces of machinery of American patterns. The most recent improvements in modern methods of making soap and candles and of glycerin recovery are described, and the last mentioned subject is treated very fully, so that for this point alone the book is almost worth its price. The space devoted to chemical analysis, on the other hand, is very restricted, and indeed no more than an outline is given, sufficient only to enable the reader to understand the basis and general method adopted in the examination of the raw materials and factory products, and for the details of the various processes he would probably find it necessary to refer to a treatise on this special branch of analysis.

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*Church's Laboratory Guide.* Revised and partly Rewritten by EDWARD KINCH, F.I.C., &c. Eighth Edition. London: Gurney and Jackson. Edinburgh: Oliver and Boyd. 1906.

MANY improvements have been made in the text of the eighth edition of Church's Laboratory Guide, although the form and general arrangement of the book have not been altered. It maintains its position as an excellent practical book intended more especially for agricultural students, for whom it gives a complete course, beginning with simple chemical operations and qualitative tests, and

passing on to the analysis of manures and feeding stuffs. In the first part of the book the reviser has added some new simple experiments, such as testing manures for nitrogen and the detection of preservatives in milk, to illustrate elementary methods of qualitative analysis and easy chemical manipulations, and new processes have also been added to the section dealing with quantitative analysis, to take the place of the descriptions of those methods which have been superseded since the issue of the seventh edition.

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*Sechs Vorträge über das Thermodynamische Potential.* ("Six Lectures on Thermodynamic Potential"). By J. J. van Laar. Braunschweig: Friedrich Vieweg und Sohn. 1906.

In these six lectures the author endeavours to show that many of the most complicated problems of chemical equilibrium may be simply and easily solved by applying the theory of thermodynamic potential. Without going very deeply into the mathematical aspects of the subject, he contrives to explain the applicability and value of this important function, and as his language is particularly clear and the thread of his argument easy to follow, even a student who has but little knowledge of physical chemistry should be able to profit by the use of the book. Many quantitative relations regarding the dissociation of gases, solubilities, and melting-points are deduced, and although the treatment is necessarily less full than in larger works, the emphasis laid on important points will recommend the book in the eyes of beginners. The six lectures are preceded by two, on concentrated solutions and on osmotic pressure respectively; in the latter the author argues very convincingly on behalf of the conception of osmotic pressure as the pressure equivalent of an ordinary diffusion process and its non-existence in isolated solutions. The criticisms of the analogy with the gas laws are ably put forward, and the author's contentions are at least worthy of careful consideration by physical chemists.

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*Untersuchungen über roten Phosphor.* ("Reseaches on Red Phosphorus"). By Dr. A. Siemens. Berlin: Julius Springer. 1906.

These researches on the properties and behaviour of red phosphorus are of special interest at the present moment when this substance is becoming of rapidly increasing technical importance, and the author's skill in experimental work has enabled him to settle conclusively some disputed points. He has worked out the details of an improved method of detecting small quantities of yellow phosphorus in the red variety, which is more reliable than Mitscherlich's test, and has also carefully investigated the changes effected by rubbing and shaking, proving that these changes consist not in a conversion into the yellow modification, but into a red phosphorus in a more finely divided state. This fresh variety of red phosphorus is more soluble and enters into reactions decidedly more readily than ordinary (red) phosphorus. A complete bibliography of literature relating to Mitscherlich's test and the detection of the element by the reduction of metallic salts, and to the conversion of yellow into red phosphorus, is added.

## MEETINGS FOR THE WEEK.

Monday, 5th.—Royal Institution, 5. General Monthly Meeting.
— Society of Chemical Industry, 8. "Advantages of Investigating the Unlikely," by Sir William Ramsay, K.C.B., &c.

Wednesday, 7th.—Society of Public Analysts, 8. "The Analyst and the Medical Man," by Dr. F. Gowland Hopkins.

Friday, 9th.—Physical, 8. Exhibition and Description of Experiments suitable for Students in a Physics Laboratory, by G. F. C. Searle

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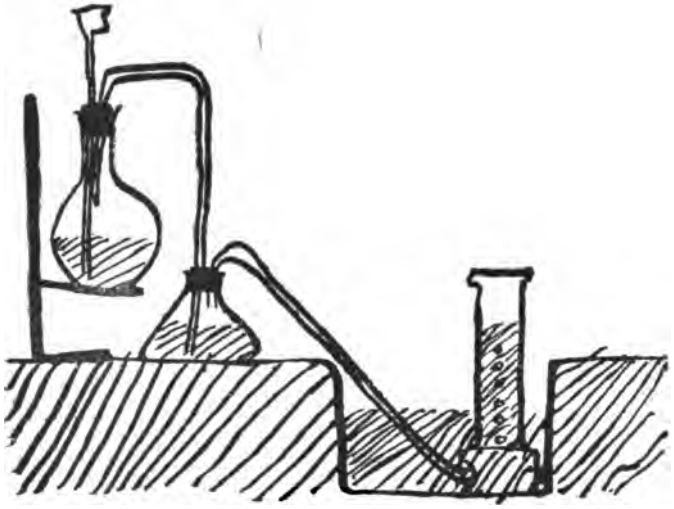

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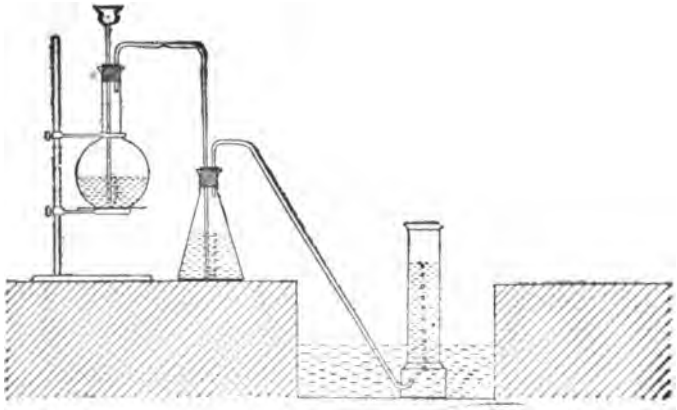

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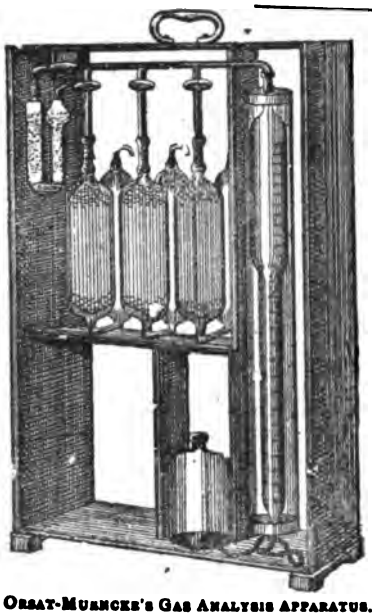

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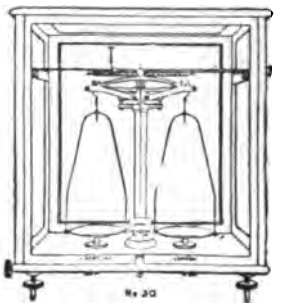

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THE CHEMICAL NEWS.

Vol. XCIV., No. 2450.

## ON A NEW METHOD FOR THE PREPARATION OF STANDARD SOLUTIONS.

By S. F. ACREE and R. F. BRUNEL.

The first difficulty that faces the individual beginning a series of exact volumetric analyses in acidimetry and alkalimetry is the preparation of an accurate standard solution of an acid or alkali. Among the acids used for making normal solutions by dissolving weighed amounts in the necessary quantity of water or other solvent, are potassium tetroxalate, oxalic acid, and succinic acid. The chief objection to these is that they are weak acids and cannot be titrated with an error of less than 0·10 per cent. The second objection is that the first two substances cannot be made with a constant amount of water of crystallisation, while if they are prepared in the anhydrous condition they do not long remain so. In solutions made from these substances by students the error may easily be 0·10—0·20 per cent.

Solutions of sulphuric and hydrochloric acids can be standardised fairly accurately by students by the barium sulphate and silver chloride methods, but this involves considerable time and care, and the barium sulphate method, especially, has several objectionable features.

In physical-chemical investigations the writers use standard solutions of hydrochloric acid and alkalis in conductivity water, which must be correct to 0·05 per cent. The standard hydrochloric acid solution is made very quickly and accurately as follows:—A clean litre flask is nearly filled with conductivity water having the room temperature, and is closed with a one-hole rubber stopper through which passes a glass tube drawn out in a long capillary, reaching nearly to the bottom of the vessel.

The flask is weighed to within 0·001 grm., with a similar litre flask filled with water on the other pan. Hydrochloric acid gas, generated from fused pure ammonium chloride and concentrated sulphuric acid and passed through two Wetzel wash-bottles containing sulphuric acid, is run into the flask until the increase in weight is a little more than a grm.-molecular weight. Before the final weighing is taken the solution must be at room temperature. Very little manipulation is required to run the exact amount of hydrochloric acid desired into the flask, but even if considerably more is obtained, the solution can be made up to the required volume by filling the flask up to the litre mark and adding the required extra volume from a burette. The contraction due to mixing 12 c.c. of water with a litre of normal hydrochloric acid solution is only about 0·0001 c.c., or practically nothing. The method adapts itself to the preparation of any smaller volume of solution of any desired strength.

Julius Thomsen (*Zeit. Physik. Chem.*, xiii., 398) tried to determine the atomic weights of hydrogen and oxygen by weighing the quantities of hydrochloric acid gas and ammonia necessary to neutralise each other. His results did not agree with those of other investigators. The reason is now apparent, as several errors were present in his work which could have been excluded.

The first source of error is that due to the absorption of moisture from the atmosphere by the calcium chloride tubes used on the flasks in which the gases were collected and weighed. This error may be quite large, and it is far better not to employ such drying tubes.

The second error is that due to his method of drying the hydrochloric acid gas. Thomsen dried the gas first with concentrated sulphuric acid, the very best method possible, and then *moistened* the gas by passing it over calcium chloride or magnesium chloride. These chlorides contain considerable water of crystallisation and oxides which would react with the hydrochloric acid and form water. As a result, the hydrochloric acid gas contained some moisture, which made the real amount of hydrogen chloride used smaller than it was thought to be.

The third source of error was in the method of drying the ammonia. Thomsen used potassium and sodium hydroxides in the stick form, in which considerable water is present. Fused potassium hydroxide, afterwards dried well over sulphuric acid, *in vacuo*, would have made this error very small. With these facts in view we shall repeat this work of Thomsen.

The normal solution made in the above way is accurate to within 0·01 per cent. The errors involved in weighing need not be more than 0·002 grm., and the moisture contained in the hydrochloric acid gas is not over 0·00005 grm., judging from the work of Dibbits (*Zeit. Anal. Chem.*, xv., 121). Such a solution gives no precipitate with barium chloride, is practically free from carbon dioxide, silicates, and all other impurities which are present in the best hydrochloric acid sold in the market. This fact is of the very highest importance to those using such standard solutions for very exact titrations or in physical-chemical investigations involving conductivity measurements. By this method a standard acid solution can be made very quickly, and its error is far smaller than that of the ordinary titration process; it can, therefore, be used directly for titration against alkalis without further standardisation. The solution keeps a long time.

In the same way standard solutions of any dry gases, such as hydrogen bromide, hydrogen iodide, hydrogen sulphide, sulphur dioxide, ammonia, chlorine, &c., in any solvent, can be prepared. The writers use this method for making standard alcoholic hydrochloric acid solutions.

For determining the strength of solutions of pure hydrochloric and sulphuric acids the following plan is much better than the silver chloride and barium sulphate methods. Sodium bicarbonate was crystallised twice and was then free from chlorides, sulphates, and silicates. Approximately 4·12 grms. of this were put into a tall beaker, covered with a watch-glass having a hole in the centre and titrated with the necessary volume, or weight of normal acid—about 50 c.c. For very accurate titrations the carbon dioxide should be removed from the solution in a vacuum, the end-point being obtained when the faintly pink solution remains unchanged in colour after standing in a vacuum for some time. The solution is then evaporated to dryness in a weighed platinum dish and heated to dull redness, until the sodium chloride is dry and the weight constant. A similar platinum dish is treated in the same way and used as a tare. From the weight of the sodium chloride or sodium sulphate and the volume or weight of the acid solution used, the strength of the latter can be easily determined. The total errors of this method should not be more than 0·05 per cent. The titration error should not be over 0·01 c.c. in 50 c.c., or 0·02 per cent, and the weighing error not more than 0·01 per cent. The method can be used for the determination of the strength of a solution of any acid whose sodium salt can be dried and weighed accurately. The titration error is larger with weaker acids.

In a similar manner the exact strength of a solution of pure sodium or potassium hydroxide can be determined by evaporating an exact amount, approximately 50 c.c., with pure hydrochloric acid. The weight of the chloride obtained and the volume or weight of the alkali solution give the data necessary for determining the strength of the alkali solution. The unknown strengths of an acid solution and of an alkali solution can be determined simultaneously by neutralising 50 c.c. of the acid solution with the necessary amount of the alkali solution and evaporating the mixture to dryness, as above. The weight of the dry salt and the volumes of acid and alkali solutions taken furnish the necessary data. The solutions of acid

and alkali must be free from appreciable quantities of silicates, chlorides, sulphates, or other impurities.

Special experiments by Mr. G. H. Shadinger showed that methyl orange is much more sensitive to carbonic acid than is popularly supposed. When carbon dioxide, purified by being passed through two Geissler potash bulbs containing sodium bicarbonate solution, was run into a solution of 3 grms. of sodium chloride in 50 c.c. of water containing a drop of 1 : 2000 solution of methyl orange, the pink colour produced was discharged by 0·06—0·40 c.c. of 0·1 N potassium hydroxide. Further experiments showed that these solutions, made pink by carbon dioxide, correspond in colour to similar solutions made pink by 0·06—0·20 c.c. of 0·1 N hydrochloric acid, the intensity of the colour varying with the degree of saturation of the solution with the carbon dioxide. When these solutions, saturated with the gas, are vigorously stirred and shaken, as in a titration experiment, the pink colour corresponds to that produced by 0·06—0·10 c.c. 0·1 N hydrochloric acid under the same conditions. Solutions made pink by carbon dioxide become brown very quickly in a vacuum, whereas similar solutions made pink by hydrochloric or sulphuric acid are not changed in colour by such treatment. It is, then, very probable that analyses of carbonates by standard acids in the presence of methyl orange, as ordinarily made, are undertitrated, and the per cent of carbonate found is too low.

*Standard Hydrochloric Acid Solutions.*

By the method described above, a hydrochloric acid solution was made up to be 0·99987 N. The molecular weight of hydrochloric acid was taken to be 36·458. If the molecular weight 36·471, found by Dixon and Edgar (Chem. News, xci., 263), which is a mean between the values found by Stas and by Richards and Wells (*Journ. Am. Chem. Soc.*, xxvii., 459) were used, the acid would be 0·99953 N.

This solution was analysed by the sodium bicarbonate method described above, but the carbon dioxide was not completely removed from the solutions. This error, however was nearly compensated by the use of the value 23·05 for the atomic weight of sodium instead of 23·01, an error of 0·08 per cent of the weight of sodium chloride. The hydrochloric acid was measured from very carefully calibrated burettes. Three analyses are given in the following table :—

| Volume of HCl solution. C.c. | Weight of NaCl. Grms. | Strength of HCl solution. |
|---|---|---|
| 30·30 | 1·7730 | 1·0002 N |
| 30·50 | 1·7833 | 0·99937 N |
| 47·24 | 2·7629 | 0·99976 N |

Average = 0·99972 N, or 0·015 per cent low.

These results show that solutions of hydrochloric acid, prepared as above, are as accurate as any ordinary analytical work requires. The writers believe that the sources of error noted above could be further reduced so that the method would serve for determining the ratio of the atomic weights of chlorine and sodium. For a number of years the value 23·05, obtained by Stas, has been generally accepted, but the recent very accurate work of Richards and Wells gives the value 23·01. If the total errors in the above method can be reduced to 0·02 per cent the writers believe it will furnish reliable evidence in favour of one or the other of the above values for sodium.

A further example of the accuracy and convenience of the sodium bicarbonate method for estimating the strength of acid solutions is given. A normal solution of sulphuric acid was made volumetrically through two other solutions, using about 15 c.c. in the titrations. The titration error might then be about 0·20 per cent. This solution was analysed by the barium sulphate method, the error being not more than than 0·10 per cent ; 20·68 c.c. gave 2·4170 grms. $BaSO_4$, or the solution was 1·0013 N. It was then analysed by the sodium bicarbonate method, under the conditions given above, with the following results :—

| Volume of $H_2SO_4$ solution. C.c. | Weight of $Na_2SO_4$. Grms. | Strength of $H_2SO_4$ solution. |
|---|---|---|
| 47·32 | 3·3722 | 1·0026 N |
| 45·33 | 3·2290 | 1·0022 N |

Mean = 1·0024

If this last value be considered accurate, the results found by the different methods check very satisfactorily. From the titrations the acid appeared to be exactly normal, but there was a possibility of 0·20 per cent error. The barium sulphate method, with a possible source of error of 0·10 per cent, gave a result 0·11 per cent below that obtained by the bicarbonate method.

*Standard Ammonium Hydroxide Solutions.*

An attempt was made to prepare standard ammonium hydroxide solutions by passing the dried gas into water in a weighed flask, under conditions similar to those employed in the preparation of standard hydrochloric acid. The concentrated commercial ammonia solution was treated with lime water to remove the carbonates ; it was then warmed gently in a flask and the gas was dried by passing it through towers containing quicklime and potassium hydroxide in sticks, and finally through a glass tube six feet in length, filled with broken potassium hydroxide, which had been fused and dried over concentrated sulphuric acid. The gas was then practically free from carbon dioxide and moisture (Van der Plaats, *Rec. Trav. Chim.*, vi., 45), and probably contained very little pyridine.

Several attempts to prepare solutions about 0·2—0·5 N showed that such solutions lose ammonia very quickly when exposed to the air or when transferred to other vessels. That the method could be relied upon to give standard solutions was proved conclusively ; such solutions, however, will not remain long unchanged.

A solution was made by passing 1·2450 grms. of ammonia into 250 c.c. of water (N = 14·04, H = 1·008). This solution was then 0·29184 N. It was analysed as follows :—Normal hydrochloric acid solution, nearly sufficient to neutralise 50 c.c. of the above ammonium hydroxide solution, was run into a beaker. The ammonium hydroxide solution was removed from the flask by means of a 50 c.c. pipette containing a small layer of ligroin to prevent the escape of ammonia, and the solution was immediately allowed to run into the hydrochloric acid solution, the point of the pipette being immersed.

Two analyses showed 50 c.c. of the ammonium hydroxide solution to be equivalent to 14·58 and 14·58 c.c. of normal hydrochloric acid ; calculated, 14·59 c.c. The strength of the ammonium hydroxide was 0·2916, or the error in the method was 0·07 per cent.

These standard solutions of hydrochloric acid and ammonium hydroxide are sufficiently accurate to warrant us in believing that the principle of using weighed quantities of well-dried gases for making up standard solutions is one worthy of further study, and this will be done in the near future.—*American Chemical Journal*, xxxvi., No. 2.

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**Institute of Chemistry.—Examinations in Chemical Technology.**—The first examinations in Chemical Technology were held at the Institute from October 16th to 18th, 1906. The examinations were open only to Fellows, and to those Associates who had been registered as such for at least one year. Each candidate was required to produce evidence of practical technological training, and to select one important industry, by which his knowledge of the subjects of the examination might be tested. The candidates who presented themselves on this occasion selected respectively Gas Manufacture, the Oils and Fats Industry, and Steel Manufacture. The papers given on the first day of the examination referred to these industries.

## THE ANALYSIS OF DITHIONIC ACID AND THE DITHIONATES.

By R. HARMAN ASHLEY.

ACCORDING to the method of analysis employed by Dymond and Hughes in the examination of potassium dithionate (*Journ. Chem. Soc.*, lxxi., 314), obtained by these investigators as a product of the interaction of potassium permanganate and sulphur dioxide, a weighed amount of the dithionate is dissolved in water, the solution is introduced into a partially vacuous closed flask containing hydrochloric acid, and, after heating, iodine is run in to determine the sulphur dioxide. In this action of hydrochloric acid decomposition takes place according to the equations $BaS_2O_6+2HCl=H_2S_2O_6+BaCl_2$ and $H_2S_2O_6=H_2SO_4+SO_2$. The sulphur dioxide formed is calculated in accordance with the expression $SO_2+I_2+2H_2O=H_2SO_4+2HI$. It is to be noted, however, that the procedure of Dymond and Hughes according to which iodine is introduced into the solution of sulphur dioxide was long ago criticised by Finkener (Finkener-Rose, "Quant. Anal.", vi. Auf., p. 837), and for it has been substituted the method suggested by Finkener and elaborated by Volhard (*Ann. Chem. Pharm.*, ccxlii., 94), according to which the solution of sulphur dioxide or the sulphite is introduced slowly from a burette into the iodine solution, the purpose being to obviate the establishment of a secondary reaction, $SO_2+4HI=2HO_2+S+2I_2$.

It seemed desirable, therefore, to study the decomposition of dithionates by boiling with hydrochloric acid under conditions which would permit the estimation of the evolved sulphur dioxide by bringing it into action in small amounts upon an excess of iodine, in accordance with the principle of the Finkener-Volhard process.

Barium dithionate was chosen as a suitable salt for investigation. It was prepared in the following manner:—Manganese dioxide suspended in water was treated with sulphur dioxide gas in a vessel surrounded with melting ice. After this treatment the solution was made alkaline with an excess of barium hydroxide to remove sulphates and sulphites as well as to convert the manganese dithionate to barium dithionate. The excess of barium hydroxide was removed by introducing carbon dioxide and boiling to break up any acid barium carbonate which might have been formed, and the solution was filtered. The filtrate from the barium carbonate contained pure barium dithionate, which was obtained in solid form by evaporating this solution.

The salt so prepared gave all the reactions of dithionic acid and had a composition corresponding to the formula $BaS_2O_6.2H_2O$. In determining the composition of the salt two methods were used. In the first, the barium was precipitated by sulphuric acid and weighed as barium sulphate; in the second method the salt was introduced into a platinum crucible and blasted to drive off water and sulphur dioxide, the residue being weighed as barium sulphate.

A salt of the formula $BaS_2O_6.4H_2O$ is said to be formed by slow evaporation ("Watt's Dict.", vol. iv., p. 696). According to my experience, however, the salt crystallised by evaporation over a flame, and that by evaporation at the ordinary temperature in a vacuum over concentrated sulphuric acid had the same composition, and both preparations gave on analysis figures corresponding to the formula $BaS_2O_6.2H_2O$, the results coming within 0·3 per cent of theory. Crystals of barium dithionate are supposed to effloresce, but no evidence of such action was found in my preparations when the crystals were kept in a weighing bottle at ordinary room temperature.

In studying the decomposition of barium dithionate under the action of hydrochloric acid, crystals of the salt were weighed out and transferred into a Voit flask provided with a separating funnel sealed on. The outlet was connected to a Drexel receiver containing a known amount of standardised iodine, and the outlet of this receiver was provided with a trap containing a solution of potassium iodide. Water was first run into the Voit flask through the separating funnel, and the salt was dissolved by the aid of heat. Acid was next run in through the separating funnel and the whole was boiled, a current of carbon dioxide being employed to sweep the sulphur dioxide into the iodine. Hydrochloric acid was added from time to time through the separating funnel to keep up the volume of the liquid and the concentration of the acid. After the operation had proceeded for the times noted, the whole was disconnected and the iodine remaining was determined by means of sodium thiosulphate with starch as an indicator. Results of experiments conducted in this manner are given in Table I.

The irregularity of these results may conceivably be due to one or more of three different reasons. In the first place, it may be that the decomposition of the dithionic acid is not complete, and that this may be so is shown by the fact that after the liquid in Experiment 10 was boiled for an hour and three-quarters and filtered from the precipitated barium sulphate, the addition of sulphuric acid caused further precipitation of barium sulphate. Secondly, it may be that some of the sulphur dioxide escapes absorption in the receiver, if the current of carbon dioxide is passed through the system too rapidly. Thirdly, the concentration of the hydrochloric acid in the receiver tends, as is well known, to render the titration of the residual iodine by sodium thiosulphate less exact and the starch iodide less delicate as an indicator.

To eliminate the concentration of acid in the receiver, in the following experiments sulphuric acid was substituted for hydrocoloric acid in the Voit flask. A weighed amount of barium dithionate was introduced into the Voit flask and there dissolved in water. Sulphuric acid was run in through the separating funnel and the mixture then boiled, the sulphur dioxide being collected in the Drexel receiver, trapped as before with potassium iodide. A slow current of carbon dioxide was driven through the system, to sweep the sulphur dioxide into the iodine and to prevent any sucking back. When boiling had been carried so far that fumes of sulphuric acid began to appear, the operation was stopped, and the excess of iodine remaining was determined by means of sodium thiosulphate, starch iodide being used as an indicator. Results of experiments carried out in this manner are given in Table II.

These results show that dithionic acid may be determined by boiling with sulphuric acid and estimating the sulphur dioxide liberated, while when hydrochloric acid is used the results are far from satisfactory.

There are three reasons why sulphuric acid should work better than hydrochloric acid in this process:—

First, when sulphuric acid is added to the solution of barium dithionate, barium sulphate is precipitated and dithionic acid is left in free condition; this reaction proceeding at once to completion, because the barium sulphate formed is removed from the system. It would seem that when hydrochloric acid is used the dithionic acid is completely liberated only by a gradual change in the conditions of equilibrium.

Second, when the solution containing sulphuric acid is boiled, the water is driven off, the concentration of the solution increases, and the high temperature of the fuming-point of sulphuric acid is reached. Under such conditions the decomposition of the dithionic acid is rapid and complete, the time being dependent upon the original dilution of the solution. In one case, No. 11, the operation was ended in four minutes.

Third, no appreciable amount of acid distils over from the Voit flask into the receiver containing the iodine to interfere with the back titration with sodium thiosulphate, the only acid present being that produced by the oxidation of the sulphur dioxide. Under these conditions the starch indicator acts sharply, which is not the case when hydro-

TABLE I.—*Decomposition of Barium Dithionate by Boiling with Hydrochloric Acid.*

| No. | $S_2O_5$ taken. | I value of $S_2O_5$ taken. | I taken. | I value of $Na_2S_2O_8$ required. | $S_2O_5$ found. | Errors in I. | Errors in $S_2O_5$. | Time. |
|---|---|---|---|---|---|---|---|---|
| | Grm. | Grm. | Grm. | Grm. | Grm. | Grm. | Grm. | Minutes. |
| 1. | 0·0854 | 0·1898 | 0·5721 | 0·3782 | 0·0872 | +0·0041 | +0·0018 | 90 |
| 2. | 0·1298 | 0·2885 | 0·5846 | 0·2920 | 0·1316 | +0·0041 | +0·0018 | 90 |
| 3. | 0·1429 | 0·3177 | 0·5778 | 0·2607 | 0·1426 | −0·0006 | −0·0003 | 45 |
| 4. | 0·1042 | 0·2317 | 0·5765 | 0·3468 | 0·1033 | −0·0020 | −0·0009 | 60 |
| 5. | 0·1031 | 0·2293 | 0·5884 | 0·3557 | 0·1047 | +0·0034 | +0·0016 | 60 |
| 6. | 0·0704 | 0·1564 | 0·5751 | 0·4228 | 0·0685 | −0·0041 | −0·0019 | 60 |
| 7. | 0·0778 | 0·1729 | 0·6194 | 0·4637 | 0·0700 | −0·0172 | −0·0078 | 60 |
| 8. | 0·1043 | 0·2319 | 0·5726 | 0·3395 | 0·1048 | +0·0012 | +0·0005 | 30 |
| 9. | 0·1043 | 0·2319 | 0·5892 | 0·3548 | 0·1054 | +0·0025 | +0·0011 | 60 |
| 10. | 0·1042 | 0·2317 | 0·6110 | 0·3849 | 0·1017 | −0·0056 | −0·0025 | 105 |

TABLE II.—*Decomposition of Barium Dithionate by Boiling with Sulphuric Acid.*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1. | 0·1039 | 0·2310 | 0·5759 | 0·3435 | 0·1045 | +0·0014 | +0·0006 | 20 |
| 2. | 0·1046 | 0·2326 | 0·5708 | 0·3372 | 0·1051 | +0·0010 | +0·0005 | 28 |
| 3. | 0·1039 | 0·2311 | 0·5740 | 0·3435 | 0·1037 | −0·0006 | −0·0002 | 34 |
| 4. | 0·1033 | 0·2297 | 0·5701 | 0·3387 | 0·1041 | +0·0017 | +0·0008 | 45 |
| 5. | 0·1721 | 0·3827 | 0·5712 | 0·1876 | 0·1726 | +0·0009 | +0·0005 | 35 |
| 6. | 0·1719 | 0·3820 | 0·5702 | 0·1894 | 0·1713 | −0·0012 | −0·0006 | 50 |
| 7. | 0·1726 | 0·3838 | 0·5734 | 0·1898 | 0·1726 | −0·0002 | 0·0000 | 12 |
| 8. | 0·1724 | 0·3832 | 0·5727 | 0·1885 | 0·1728 | +0·0010 | +0·0004 | 10 |
| 9. | 0·1721 | 0·3826 | 0·3727 | 0·1886 | 0·1728 | +0·0015 | +0·0007 | 10 |
| 10. | 0·0692 | 0·1539 | 0·3130 | 0·1599 | 0·0689 | −0·0008 | −0·0003 | 12 |
| 11. | 0·0350 | 0·0777 | 0·3109 | 0·2323 | 0·0354 | +0·0009 | +0·0004 | 4 |
| 12. | 0·2061 | 0·4582 | 0·6205 | 0·1632 | 0·2057 | −0·0009 | −0·0004 | 15 |
| 13. | 0·2402 | 0·5340 | 0·6215 | 0·0862 | 0·2408 | +0·0013 | +0·0006 | 15 |

chloric is used.—*American Journal of Science*, 1906, xxii., p. 259.

## A REVISION OF THE ATOMIC WEIGHT OF CADMIUM.*

By GREGORY PAUL BAXTER, MURRAY ARNOLD HINES, and HARRY LOUIS FREVERT.

FROM a recent investigation of the atomic weight of cadmium (Baxter and Hines, *Journ. Am. Chem. Soc.*, 1905, xxvii., 222) the value 112·469 (Ag = 107·930) for this constant was obtained by analysis of cadmium chloride. Since this value is nearly one-tenth of a unit higher than the results of recent prior determinations by other investigators, in order to confirm or disprove the higher value the analysis of cadmium bromide was undertaken.

### *Purification of Materials.*

In the previous investigation the cadmium material was purified by fractionally precipitating cadmium sulphide with hydrogen sulphide from an acid solution of cadmium chloride. Two small fractions were rejected, and the next three (which included very nearly all the remainder of the cadmium) were preserved separately. Each one of these three fractions was first thoroughly washed, then dissolved in hydrochloric acid and re-precipitated. Next the precipitates were again dissolved in nitric acid, the nitric acid was expelled by heating with an excess of sulphuric acid, and the sulphate was re-crystallised thrice from pure water. Fraction I. and a portion of Fraction II. were converted into chloride and were analysed in the earlier work, while Fraction III. and a second portion of Fraction II. were converted into bromide.

The method employed for this purpose was that of depositing metallic cadmium electrolytically, dissolving the metal in bromine under water in a quartz dish, and re-crystallising the bromide in platinum vessels. In the first experiments electrolysis was carried on in a solution of the sulphate in pure water between two electrodes of platinum-foil. A sponge of extremely small crystals was thus produced. These crystals contained occluded sulphate in considerable quantities, and no amount of washing with water was sufficient completely to leach out this occluded material. Hence the bromide made from this metal was sufficiently contaminated with sulphate, which was finally eliminated with difficulty by repeated crystallisation. This bromide was used only in preliminary experiments. More satisfactory results were obtained by depositing the metal upon a platinum dish which had been covered with a very thin film of soft paraffin, so that the deposit could be readily separated from the dish (Richards, *Proc. Amer. Acad.*, 1890, xxv., 200). The cadmium was first washed with water, then with ether, next with alcohol, and finally with water again. This treatment effectually cleansed the metal from paraffin. In order to convert the cadmium into bromide, it was covered in a quartz dish with water slightly acidified with hydrobromic acid, to prevent the formation of basic cadmium salts, and the purest bromine was added in small quantities until the metal was almost wholly dissolved. The solution was heated with the residual metallic cadmium upon a steam-bath until every trace of bromine had disappeared. Then it was filtered with a platinum funnel into a platinum dish, and was re-crystallised three times, with centrifugal drainage in the platinum funnel after each crystallisation (Richards, *Journ. Am. Chem. Soc.*, 1905, xxvii., 110). The original solution contained only traces of sulphate, and, when tested with barium hydroxide, the mother-liquors of the third crystallisation gave absolutely no test for sulphate, hence the crystals themselves must have been pure (Samples II.*a* and III.*a*). From the mother-liquors of each fraction, by three crystallisations, similar samples were obtained (Samples II.*b* and III.*b*). The crystals were dried over potassium hydroxide in a vacuum desiccator.

Commercial bromine was freed from chlorine by two distillations from a concentrated solution of a bromide, the bromide in the second distillation being almost free from chloride. The bromine was covered with water, and hydrogen sulphide (which had been thoroughly washed with water) was passed into the solution until reduction of the bromine was complete. The solution was boiled, after mechanical separation of the greater part of the free sulphur and bromide of sulphur, and was filtered. Iodine was eliminated by boiling the hydrobromic acid with

* From the *Journal of the American Chemical Society*, xxviii., No. 6.

several small portions of potassium permanganate and rejecting the bromine set free. By heating the remainder of the hydrobromic acid with an excess of permanganate, over half of the bromine was obtained in the free state. The process of reduction with hydrogen sulphide and oxidation with permanganate was then repeated with the resulting bromine, and the final product was re-distilled shortly before use.

One sample of silver was purified especially for this research. The processes to which it was subjected were essentially those which have been repeatedly used in the Harvard Laboratory for the purification of silver. The commercial metal was dissolved in nitric acid, and the solution was filtered and precipitated at considerable dilution with hydrochloric acid. After thorough washing, the precipitate was reduced with invert sugar and sodium hydroxide, and the metallic silver was fused with a blowpipe on a crucible of the purest lime. In order to cleanse the buttons from surface impurities, they were first scrubbed with moist sand, and then the surface was removed with dilute nitric acid. Next the buttons were dissolved in nitric acid and the solution was reduced with ammonium formate (Richards, Publications of the Carnegie Institution, 1905, No. 28, p. 19; *Journ. Am. Chem. Soc.*, xxvii., 475). The precipitated silver was thoroughly washed, and again fused in a lime crucible. The final process of purification consisted in electrolysing the silver with a solution of silver nitrate (made from a portion of the silver acting as electrolyte, while the anode was a pile of the pure silver buttons and the cathode a bar of the purest silver). The electrolytic crystals were washed, dried, and fused in a current of pure hydrogen on a lime boat. The buttons were cleansed with dilute nitric acid, and, after drying at 200°, they were cut into fragments with a clean chisel and anvil. Then they were again treated with fresh portions of dilute nitric acid until free from iron, washed, dried, and finally heated to about 400° in a vacuum. This silver was employed in Analyses 4 to 8.

In the first three analyses a mixture of two specimens of silver was employed, both of which had already been used in an investigation upon the atomic weight of iodine by one of us (Baxter, *Proc. Am. Acad.*, 1905, xli., 73). One was prepared from silver nitrate which had been seven times re-crystallised from nitric acid, five times re-crystallised from water, and finally precipitated with ammonium formate. The other was precipitated once as silver chloride, electrolysed once, and finally reduced with ammonium formate.

Water was purified by double distillation with tin condensers, first with alkaline permanganate, finally with a trace of sulphuric acid. Nitric acid was twice distilled with a platinum condenser, the first third of the distillate being rejected in both distillations. The product of the first distillation contained only the merest trace of chlorine.

### *Method of Analysis.*

The method of analysis was essentially that already frequently employed in this laboratory for the analysis of metallic halides. Weighed portions of the bromide, after fusion in nitrogen and hydrobromic acid gases, were first titrated against weighed portions of silver. Then the precipitated silver bromide was collected and weighed.

The apparatus used for the fusion of the salt in hydrobromic acid gas was employed in the preparation of ferrous bromide by one of us (Baxter, *Proc. Am. Acad.*, xxxix., 246), and is a modification of apparatus used for a similar purpose in the determination of the atomic weights of cobalt (Richards and Baxter, *Ibid.*, xxxiii., 117), nickel (Richards and Cushman, *Ibid.*, xxxiii., 99), and uranium (Richards and Merigold, *Ibid.*, xxxvii., 378) in this laboratory. A mixture of air and ammonia was passed over heated rolls of copper gauze, and the excess of ammonia was removed by means of sulphuric acid. The gas was then conducted into an apparatus constructed wholly of glass, with ground joints, which consisted of a tower filled with beads moistened with silver nitrate solution to remove sulphur compounds, two similar towers containing dilute sulphuric acid to eliminate last traces of ammonia, and two towers filled with sticks of fused potassium hydroxide to absorb moisture and carbon dioxide. The partially dried gas, after bubbling through bromine in a small flask, passed into a second flask containing concentrated hydrobromic acid solution in which washed red phosphorus was suspended, to convert the bromine into hydrobromic acid. A U-tube, also containing red phosphorus and hydrobromic acid, removed traces of bromine which escaped reduction in the flask. Two additionnl U-tubes containing beads moistened with concentrated hydrobromic acid only, served to eliminate phosphorus compounds which were found, in the nvestigation upon ferrous bromide (*loc. cit.*), to accompany the hydrobromic acid if the phosphorous acid in the reduction flask was allowed to become very concentrated. Finally, the mixture of nitrogen and hydrobromic acid gases was thoroughly dried, first by pure fused calcium bromide, and then by re-sublimed phosphorus pentoxide.

The cadmium bromide, contained in a weighed platinum boat, was heated gently in a current of nitrogen until a small quantity of residual crystal water was expelled, then strongly in a current of nitrogen and hydrobromic acid until fused. After the salt had cooled, the hydrobromic acid was displaced by nitrogen and this in turn by dry air. The boat was then transferred to the weighing-bottle in which it was originally weighed, and the stopper was inserted without an instant's exposure of the salt to moisture; by means of the bottling apparatus which has been frequently described in papers from this laboratory (Richards and Parker, *Proc. Am. Acad.*, xxxii., lix.). The weighing-bottle was then allowed to stand in a desiccator near the balance case for some time before it was weighed.

Next the boat was transferred to a flask, and the salt was dissolved in about 300 c.c. of the purest water. The weighing-bottle was rinsed, and the rinsings were added to the solution. Then the solution was filtered into the glass-stoppered precipitating flask through a tiny filter to collect a trace of insoluble matter, and the filter-paper and residue were ignited at a low temperature in a weighed porcelain crucible. This residue, which usually amounted to less than 0·1 m.grm. and was never as much as 0·2 m.grm., did not contain detectable quantities of cadmium, and probably consisted of silica and a trace of platinum removed from the boat during the fusion, for the boat, when re-weighed, in most cases was found to have lost a few hundredths of a milligrm. No change in weight could be found when the boat was first dried and weighed, then ignited and re-weighed. The difference between the weight of the residue and the loss in weight of the boat was subtracted from the weight of the cadmium bromide.

(To be continued).

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**Mechanism of Ionisation by Solution.**—Gustave D. Hinrichs.—During the solution of a salt in water the contact of the molecules of the solid with the rotating molecules of water electrically insulated produces statical electricity. The two electricities, positive and negative, are produced in exactly equal quantities. This electricity cannot escape across the insulated water, and the two atoms of the molecule of the salt are charged. Taking, for example, sodium chloride, the sodium atom receives a positive charge, that of chlorine a negative one. By this means the chemical combination of the two atoms is dissociated, and the two atoms each charged become the ions. If the solution is dilute enough, each molecule of the salt is surrounded by a large number of the non-conducting water molecules. In such a case the ions produced will be well insulated, and can move freely without losing their electric charge. If, however, the solution is stronger, the number of molecules of water for each molecule of salt is diminished, and the molecular insulation of the ions also diminishes; that is to say, the percentage of the molecules in the solution which become ionised diminishes rapidly with the concentration of the solution, so there can only be complete ionisation when the solution is very dilute.—*Comptes Rendus*, cxliii., No. 16.

# PROCEEDINGS OF SOCIETIES.

## CHEMICAL SOCIETY.

*Ordinary Meeting, October 18th, 1906.*

Prof. Sir William Ramsay, K.C.B., F.R.S., Foreign Secretary, in the Chair.

### *Presentation of the Longstaff Medal.*

In the absence of the President through illness, the following Address from him was communicated :—

The Longstaff Medal, as announced last Session, has been awarded to Prof. Walter Noel Hartley for his researches in Spectro-chemistry. It is over a quarter of a century since Hartley first entered this domain of physical chemistry which he has since cultivated with unremitting zeal and conspicuous success. To him belongs the distinct credit of being among the first to realise that valuable informating concerning the constitution of chemical compounds might be obtained by the study of their absorption spectra, not only within the region of the visible spectrum, but, what is of far greater importance, in that ultra-violet region which is so easily dealt with by the photographic plate. His first contribution (in conjunction with Prof. Huntingdon) appeared in 1879, and must be regarded as the pioneer research which laid the foundation of all subsequent work in the systematic study of absorption spectra carried out by Hartley himself in conjunction with various collaborators or by independent workers inspired by the success of the method. The merits of this first memoir and of all the results which have followed from it consist not only in the establishment of the principle of a relationship between a particular optical property of a molecule and its chemical structure, but in the practical development of the methods by which this principle has been established. Setting out originally with the object of studying the ultra-violet absorption spectra of compounds of known constitution by means of the photographic plate, Hartley was soon compelled to turn his attention to emission spectra, and his well-known tin-lead-cadmium alloy was devised and used as a means of supplying spark spectra rich in ultra-violet lines of known wave-lengths. His later incursions into this field of spectroscopy are sufficiently well known. It is only necessary to refer to his spectrographic method of studying alloys and his researches on flame spectra and their applications to mineral analysis and to metallurgical processes. While there is no branch of spectro-chemistry which he has handled to which Hartley has not made valuable contributions, it is for the long series of researches on the relationship between absorption spectra and chemical constitution commencing in 1879 and continuing down to his latest communication published in last year's volume of our *Transactions* that the Longstaff Medal is more especially awarded. Although associated with many colleagues in the course of this work, the main source of inspiration has doubtless been Hartley himself. By his labours he has placed in the hands of chemists a method of studying chemical constitution which must for all time be taken into consideration. It is not only the method itself, but the mode of expressing the results by what he called "curves of molecular vibration" that first enabled chemists to realise the power of the new weapon. The continuous series of investigations proceeding from Hartley and his colleagues since 1879, and the more recent and no less important contributions now being made by other workers in the same field, all bear witness to the fertility of this spectroscopic method. An appeal to the more modern literature of the subject will show that not only has the original conception of the pioneer been amply justified, but that his methods have shown themselves capable of dealing with the more recondite problems of isomerism and tautomerism in its various aspects, and the relationship between colour and chemical constitution. It is perhaps safe to say that no discussion on this latter subject can lead to definite conclusions if absorption spectra be ignored.

In presenting the Longstaff Medal to Prof. Hartley it will doubtless be the unanimous desire of the Fellows of the Chemical Society that the presentation should be accompanied by the wish that he may long be spared to carry on that branch of physico-chemical work of which he is practically the founder, and with the development of which his name will always be honourably associated to the lasting credit of British Science.

The Longstaff Medal was then presented to Professor Walter Noel Hartley by the Chairman, and duly acknowledged.

Messrs. G. H. A. Clowes, B. Flurscheim, S. S. Pickles, H. Rogerson, and H. W. M. Willett were formally admitted Fellows of the Society.

The Chairman stated that on the occasion of the Jubilee of the Foundation of the Coal-tar Colour Industry celebrated in July, the following Address was presented to Sir William H. Perkin by the President :—

*To* William Henry Perkin, LL.D., Ph.D., F.R.S.
*From the Chemical Society.*

Among those who congratulate you on the occasion of the celebration of the fiftieth anniversary of your discovery of the first Coal-tar Colour, the Chemical Society is not only aware of your great services to Chemical Science and Chemical Technology, but may claim to know you more intimately than any other body. Elected a Fellow in the year in which you began to manufacture Mauve, you are one of its oldest members ; as one of its Secretaries during the years 1869-83, and as its President in 1883-85, you have rendered most valuable service in the conduct of its affairs ; but it is chiefly for your many contributions to its *Proceedings* that it is indebted to you. Singularly consistent in your choice of the Society's publications as the means of making your work known, you have at all times been one of the chief supporters of its efforts to promote the progress of Chemical Science.

It is impossible to overrate the value directly and indirectly of your discovery ; the evidence of the influence which it has exercised is overwhelming. And it is noteworthy that you should have been active not only at the beginning of the colour industry, but that you have more than once intervened to assist its progress ; notably by the part which you took in the development of the manufacture of the Madder colours ; by your work on Cinnamic acid which was of critical importance in the early stages of the development of the artificial indigo industry ; and by your discovery of a method of producing Coumarin artificially which entitles you to rank as the pioneer in the establishment of an important offshoot of the colour industry, that of artificial perfumes.

The extraordinary progress of Chemical Science during the past half century indeed is in a very large measure the outcome of your discovery ; had it not been proved to be a useful science, Chemistry would never have attracted the army of workers whose victories have led to the marvellous developments which are to be chronicled on every side. The advance of knowledge is little short of miraculous, especially in view of the difficulties with which chemists are confronted.

But however highly your technical achievements be rated, those who have been intimately associated with you must feel that the example which you have set by your rectitude as well as by your modesty and sincerity of purpose is of chiefest value. That you should have been able, as a very young man, to overcome the extraordinary difficulties incident to the establishment of an entirely novel industry fifty years ago, is a clear proof that you were possessed in an unusual degree of courage, independence of character, judgment, and resourcefulness ; but even more striking is your return into the fold of scientific workers and the ardour with which you have devoted yourself to the prosecution of abstract physico-chemical

inquiries of exceptional difficulty. In the account of your renowned Master, Hofmann, you have stated that one of your great fears on entering into technical work was that it might prevent your continuing research work; that you should have felt such regret at such a period is sufficiently remarkable, and it must be a source of enduring satisfaction to you to know that your later scientific work deserves, in the opinion of many, to rank certainly no less highly than your earlier.

It is with a feeling of just pride that the Chemical Society now places on record its deep sense of the obligation which you have laid upon it by having won for British Chemical Science the incomparable distinction of making so great a step in the progress of civilisation as is marked by your discovery and its consequences.

Signed on behalf of the Chemical Society this Twenty-sixth day of July, 1906,

Raphael Meldola, President.
Alexander Scott, Treasurer.
M. O. Forster, Arthur W. Crossley, Honorary Secretaries.
William Ramsay, Foreign Secretary.

It was also announced that during the celebration by the University of Aberdeen of its Fourth Centenary, the following Address was presented in the name of the Society by the President:—

*To the University of Aberdeen.*

On behalf of the Chemical Society we beg to offer our most hearty congratulations to the University of Aberdeen on the occasion of the celebration of its Fourth Centenary. At an early period in its history the University gave prominence to Chemistry, and by so doing has rendered the greatest service to our Science as an educational subject. The University Chair of Chemistry has been filled successively by a number of distinguished men, Fellows of our Society, many of whom have extended the boundaries of Scientific Knowledge by their original investigations.

The inauguration of the new buildings will be regarded as marking the commencement of a new period of useful activity in the educational history of this country. The establishment of the new Laboratories will give the greatest satisfaction to English Chemists, as it is recognised that the improved facilities for instruction and research thus placed at the disposal of the University will insure the future development of their Science in Aberdeen, both as a branch of Academic Learning and as a subject of the greatest importance to the material welfare of the Nation.

In the name of the Council and Fellows of the Chemical Society we desire to place on record our most sincere wishes for the continued prosperity of the University of Aberdeen, both in our own Department of Scientific Knowledge and in all those studies which during the four past centuries it has fostered with such conspicuous success.

Signed on behalf of the Chemical Society this Twenty-sixth day of July, 1906,

Raphael Meldola, President.
Alexander Scott, Treasurer.
M. O. Forster, Arthur W. Crossley, Honorary Secretaries.
William Ramsay, Foreign Secretary.

Certificates were read for the first time in favour of Messrs. Paul Seidelin Arup, M.A., Marsden Villa, 62, Haverstock Hill, N.W.; Oscar Walter Bethea, Meridian, Miss., U.S.A.; James Spears Broome, B.Sc., 18, Seedley Park Road, Pendleton, Manchester; Thomas Henry Byrom, 31, Wrightington Street, Wigan; John Carmichael, 10, Cortayne Road, Fulham, S.W.; Percy Henry Carpenter, A.I.C., 46, Streathbourne Road, Upper Tooting, S.W.; Charles Taylor Cockburn, 34, Queen's Gate, Dowanhill, Glasgow; Hubert Frank Coward, M.Sc., Hulme Hall, Plymouth Grove, Manchester; Archibald Prideaux Davson, A.R.C.S., 39, Blandford Square, N.W.; Anthony Nisbet Fitzgerald, B.A., B.Sc., 12, St. Mary's Road, Strood, Rochester; Octavius Hall, L.R.C.S., L.R.C.P., 6, Devonshire, Villas Plymouth; H. Norman Hanson, Field Head, Brighouse, Yorks; Charles Percy Hines, B.Sc., The Grammar School, Dartford; Edward Rees Jones, Llangedwyn Vicarage, Oswestry; William Richard Simpson Ladell, 19, Alwyne Road, N.; David McIntosh, B.Sc., Stamford School, Stamford; John Mastin, Woodleigh House, Totley Brook, nr. Sheffield; George Naylor, 45, Hornby Road, Blackpool; Charles Harold Oxland, B.Sc., 37, Waterloo Road, Bedford; Frederic Ion Richardson, B.A., Glenarbor, Kew, nr. Melbourne, Australia; Reginald Ernest Robinson, B.A., The Villas, Stoke-on-Trent; John Lionel Simonsen, M.Sc., 152, Barlow Moor Road, West Didsbury, Manchester; Charles Smith, Knowsley Road, Smithells, Bolton; Harry George Telling, Cooksbridge, Sussex; George Gordon Watt, 26, Albert Square, Clapham Road, S.W.; Chr. Winther, The University, Copenhagen.

Of the following papers, those marked * were read:—

*170. "*The Description and Spectrographic Analysis of a Meteoric Stone.*" By Walter Noel Hartley.

This stony meteorite was seen to fall in the Kangra Valley, Northern Punjaub, in 1897, and was received in the same year from Lieut.-Col. Donald St. John Dundas Grant, of the India Medical Service. It consists of a crystalline stony base, throughout which are dispersed bright silvery metallic particles from 0·5 to 1 m.m. in diameter. The analysis was carried out according to the method previously described (Hartley and Ramage, *Trans.*, 1901, lxxix., 61). The principal constituents of the metallic portion are iron, nickel, cobalt, and chromium, with small quantities of copper, silver, lead, and gallium. Manganese, calcium, potassium, and sodium are present only in minute proportions. The chief components of the silicates other than silica are calcium and magnesium oxides. The bases present in minute proportions are iron, nickel, chromium, strontium, lead, silver, manganese, potassium, and sodium.

*171. "*Malacone, a Silicate of Zirconium containing Argon and Helium.*" By Stanhope Kitchin and William George Winterson.

This mineral, found at Hitteroe and Arendal, Norway, is radio-active, and gives off a mixture of helium and *argon* when heated. As it is the only mineral from which argon has been obtained, a careful analysis was made with the object of seeing whether the presence of any unknown or unusual constituent would account for the presence of the argon. The analysis, discounting ferric oxide, uranium oxide, &c., points to the ratio $3ZrO_2 : 2SiO_2$ between the zirconia and the silica. The zirconia, converted into the basic chloride $ZrOCl_2$ and fractionally crystallised, was found to give the ratio 1 : 2 between the zirconium and chlorine, taking the atomic weight of zirconium at its accepted value, 90.

The mineral is feebly radio-active, and its radio-activity is considerably higher than that deduced from its content of uranium; but it still remains to make a careful examination of the nature of the emanation evolved, which, although it has a considerable period of decay, has not been proved to be identical with that from radium.

*172. "*The Relationship of Colour and Fluorescence to Constitution.* Part I. *The Condensation Products of Mellitic and Pyromellitic Acid with Resorcinol.*" By O. Silberrad.

Mellitic and pyromellitic acids condense with resorcinol to form compounds analogous to fluorescein.

Mellitic acid forms three series of products, namely, mono-, di-, and tri-xanthydryl derivatives, of which the dixanthydryl derivatives exist in two modifications, namely, meta and para. Pyromellitic acid forms mono- and di-xanthydryl derivatives. Representatives of all of these classes have been prepared.

One of the chief interests of the work lies in its bearing on the quinone theory of the structure of the phthaleins. Many of the compounds described do not admit of formulation on the quinone type, but are nevertheless intense

colouring matters and strongly fluorescent. The analogy between these compounds and the phthaleins is so close that it appears very probable that the latter also contain no quinone group.

Indications have also been obtained that the change from a lactonic structure to that of a carboxylic acid and *vice versâ* does not take place with the ease which has generally been assumed; this also has an important bearing on the supposed tautomerism of the phthaleins.

The structure of the melliteins and pyromelliteins follows in general from the method of preparation and the results of analysis. In the case of the dixanthydryl derivatives, it was necessary to differentiate between the meta- and para-isomerides, by determining whether they were capable of further combining with resorcinol.

The following compounds, together with their *potassium*, *lithium*, *ammonium*, *copper*, *lead*, *mercury*, *barium*, *cobalt*, *iron*, and *silver* salts, were investigated.

3 : 6 : 9 - *Trihydroxyxanthydrylbenzene-2-carboxylactone-4 : 5-dicarboxylic acid*, together with its *tetrabromo-* and *tetraiodo*-derivatives.

3 : 3′ : 6 : 6′ : 9 : 9′-*Hexahydroxy*-m-*dixanthydrylbenzene-2 : 4 : 5 : 6-tetracarboxylic acid* and its *octobromo*-derivative.

3 : 3′ : 6 : 6′ 9 : 9′-*Hexahydroxy* - p - *dixanthydrylbenzene-2 : 3 : 5 : 6-tetracarboxylic acid*.

3 : 3′ : 3″ : 6 : 6′ : 6″ : 9 : 9′ : 9″ - *Nonohydroxy* - sym - *trixanthydrylbenzene* : 2 : 4 : 6-*tricarboxylic acid*, together with its *dodecabromo-* and *dodecaiodo*-derivatives.

*173. "*Separation of αα- and ββ-Dimethyladipic Acids.*" By Arthur William Crossley and Norah Renouf.

Experiments were described by which it has been found possible, contrary to the statement of Blanc (*Bull. Soc. Chim.*, 1905, [iii.], xxxiii., 879), to separate αα- and ββ-dimethyladipic acids. The method depends on the different solubilities of these two acids in water saturated with hydrogen chloride, and in a mixture of chloroform and light petroleum.

*174. "*Action of Alcoholic Potassium Hydroxide on* 3-*Bromo* - 1 : 1 - *dimethylhexahydrobenzene.*" By Arthur William Crossley and Norah Renouf.

Further investigation of 1 : 1-dimethyl-$\Delta^3$-tetrahydrobenzene (*Trans.*, 1905, lxxxvii., 1499), prepared by the action of alcoholic potassium hydroxide on 3-bromo-1 : 1-dimethylhexahydrobenzene, has shown it to be a mixture of this hydrocarbon with the isomeric 1 : 1-dimethyl-$\Delta^4$-tetrahydrobenzene, in which the former always predominates.

This has been rendered possible by the discovery of a means of separating the oxidation products of these two substances, namely, αα- and ββ-dimethyladipic acids.

*175. "*The Conversion of Morphine and Codeine into Optical Isomerides.*" (Preliminary communication). By Frederic Herbert Lees and Frank Tutin.

It was demonstrated by Schryver and Lees (*Trans.*, 1900, lxxvii., 1024, and 1901, lxxix., 563) that the chloro- and bromo-derivatives of morphine and codeine of the respective types $C_{17}H_{18}O_2N{\cdot}X$ and $C_{18}H_{20}N{\cdot}X$, prepared and described by them (*loc. cit.*), do not regenerate simply the original bases when they are hydrolysed by water. In every case a mixture of bases isomeric with the parent substance was produced, and of these *iso*morphine, β-*iso*morphine, and *iso*codeine were isolated and described. As *iso*morphine appeared to be the chief product of the action of water on bromomorphide (m. p. 170°) it was fully studied in order to obtain information respecting its relation to morphine. Of the two theories advanced respecting this relation, that of stereoisomerism was at the time considered to be the less probable.

From the consideration of the fact that Schryver and Lees demonstrated a complete chemical analogy between morphine and *iso*morphine (compare also Knorr and Hawthorne, *Ber.*, 1902, xxxv., 3010), and that the only differences between the bases are of a purely physical character and such as are found among optical isomerides, the present authors conclude that the isomerism must without doubt be optical in character. Experimental evidence confirming this view has now been obtained.

Since the scope of the present investigation, on which the authors have been engaged for some time, has necessarily become extended to a study of the products of the hydrolysis of all the mono-halogen derivatives of morphine and codeine, they intended to delay publication until the whole subject was completed. The appearance, however, of a recent paper by R. Pschorr (*Ber.*, 1906, xxxix., 3130), entitled "Halogen Derivate von Morphin und Codein und deren Abbau," from which it is evident that the halogen derivatives obtained by Schryver and Lees are receiving attention, renders it desirable that the authors should publish some of their results and conclusions in order to indicate the lines on which they are still working.

Bromocodeide (m. p. 162°), on hydrolysis with water, gives an optically active mixture consisting, in unequal proportions, of bases isomeric with codeine. By fractionally crystallising the mixture from ethyl acetate and from alcohol, until products were obtained which showed no change in melting-point and specific rotatory power, the following substances were isolated :—

*A-Base.*—This formed slender prismatic needles melting at 145—145·5°, and had $[\alpha]_D$ − 205° in chloroform.

*B-Base.*—This formed colourless tabular prisms melting at 171—172°, and had $[\alpha]_D$ − 155° in chloroform.

When codeine is treated with excess of phosphorus tribromide in chloroform, the reaction is most vigorous, and bromination is almost immediately complete. When this solution is heated on a water-bath for a quarter of an hour, instead of for one hour, as was previously the case, the resulting bromo-derivative apparently contains less of the crystalline bromocodeide (m. p. 162°), and is a mixture. When this product is hydrolysed with water and the resulting mixture of isomeric codeines fractionally crystallised, codeine (m. p. 155°, $[\alpha]_D$ − 122°) was isolated in addition to the above-mentioned A- and B-bases.

The substance described above as the B-base has now been shown to be *iso*codeine, the codeine analogue of *iso*morphine, for it is readily produced from the latter by methylation with sodium ethoxide and dimethyl sulphate. The *iso*codeine obtained by Schryver and Lees (*loc. cit.*) was apparently contaminated with a small proportion of the A-base.

The A-base, although undergoing no resolution by numerous crystallisations from several solvents, has been proved to be a molecular mixture of *iso*codeine (m. p. 171—172°) and a more highly lævorotatory isomeride which has not yet been prepared in the pure state.

By the reactions mentioned, the authors have thus obtained conclusive evidence of the formation in unequal proportions of codeine and two other optically isomeric lævorotatory bases.

These facts permit of the following conclusions respecting the constitution of morphine :—

1. The above-mentioned isomeric codeines are the result of the racemisation of two asymmetric carbon atoms in a molecule which must necessarily contain a third asymmetric system.

2. The carbon atoms which undergo racemisation are most probably those in the reduced phenanthrene nucleus to which the alcoholic hydroxyl group and the nitrogen atom are respectively attached. It follows from this that the latter carbon atom must necessarily be hydrogenised in order to be asymmetric.

3. The possible isomeric codeines produced by the racemisation of the two asymmetric carbon atoms must be represented by the configurations + + −, + − −, − −, − − −, as at least three of them are lævorotatory.

176. "*The Aminodicarboxylic Acid derived from Pinene.*" By William Augustus Tilden and Donald Francis Blyther.

This is the acid originally obtained by Tilden and Burrows (*Trans.*, 1905, lxxxvii., 344). In the present communication details are given for the preparation of the acid and its *hydrochloride*, *nitrate*, *acid oxalate*, *copper* salt,

*ethyl* ester, and its *hydrochloride*, and the *acetyl* derivative of the amino-acid.

Experiments are being continued on the products of the oxidation of the acid and of its condensation with benzaldehyde and glycocine.

177. "*The Preparation and Properties of Dihydropinylamine* (*Pinocamphylamine*)." By WILLIAM AUGUSTUS TILDEN and FREDERICK GEORGE SHEPHEARD.

*Dihydropinylamine* is the chief product of the reduction of nitrosopinene by means of boiling amyl alcohol and sodium. The free base is a colourless liquid having an odour like pinylamine, and boiling at 198—199°.

The *hydrochloride*, *platinichloride*, *picrate*, *nitrate*, *oxalate*, also the *acetyl* and *benzoyl* derivatives, and the *carbamide*, have been prepared and analysed. The alcohol obtained by the action of nitrous acid on the aqueous solution of the hydrochloride of the base boils at 103° under 15 m.m. pressure, and is identical with pinocampheol prepared by reduction of pinocamphone.

178. "*Determination of Nitrates.*" By FRANK STURDY SINNATT.

Knecht and Hibbert's method for the estimation of picric acid (*Ber.*, 1903, xxxvi., 1549) may be applied to the estimation of nitrates.

The process depends on the conversion of the nitrate into picric acid by means of phenolsulphonic acid, the picric acid being subsequently estimated by titanium trichloride.

Up to the present the method has only been used for the estimation of re-crystallised pure potassium nitrate; it was carried out as follows:—

Ten c.c. of the solution of potassium nitrate containing 0·1 per cent of potassium salt were evaporated to dryness in a steam oven, 5 c.c. of a solution of phenolsulphonic acid added, and the heating continued for half-an-hour. The whole was then washed into a flask, and, after adding hydrochloric acid, titrated with titanium trichloride.

Three titrations carried out in the above manner required, for 0·01 grm. of potassium nitrate, 20·14, 20·47, and 20·2 c.c. of titanium trichloride (1 c.c. = 0·0004860 grm. of potassium nitrate), corresponding to 0·009788, 0·009948, and 0·009817 grm. of potassium nitrate respectively. The error is not so great as when the colorimetric method is used.

179. "*The Nature of Ammoniacal Copper Solutions.*" By HARRY MEDFORTH DAWSON.

The nature and dissociation of the complex cupri-ammonia compound which is present in ammoniacal solutions of copper sulphate has been further examined. The method consisted in determining the amount of free ammonia in variously concentrated copper solutions containing different relative amounts of ammonia by extracting these solutions with chloroform. Special precautions have been taken with the view of obtaining accurate results, and a correction has been applied for the ammonia-displacing action of the dissolved salt. The experimental data indicate the existence in solution of a dissociating complex compound containing four molecules of ammonia per atom of copper. The ammonia dissociation increases with dilution, and, for a given copper concentration, with decrease in the relative proportion of ammonia. From experiments in which the free ammonia in ammoniacal copper sulphate solutions was determined by the method of gas-bubbling, Locke and Forssall (*Am. Chem. Journ.*, 1904, xxxi., 268) have drawn the conclusion that such solutions contain practically the whole of the copper in the form of a stable complex ion, $Cu{\cdot}4\dot{N}H_3$. According to the author's observations, this view is quite untenable.

180. "*The Colouring Matters of the Stilbene Group.*" (Part III.). By ARTHUR GEORGE GREEN and PERCY FIELD CROSLAND.

In previous communications (*Trans.*, 1904, lxxxv., 1424, 1432) it has been shown that the first action of caustic alkalis on *p*-nitrotoluenesulphonic acid is the production of an unstable and easily oxidisable dinitrosostilbenedisulphonic acid.

In order to study the subsequent transformation of this intermediate product by which dye-stuffs of the stilbene series are produced, typical colouring matters of this class, namely, stilbene yellow 8G and 4G, direct yellow, and Mikado orange, were submitted to examination by the following methods:—

A. Estimalion of the quantity of hydrogen required to reduce the dye-stuff to diaminostilbenedisulphonic acid, employing for this purpose titration with standard titanium trichloride.

B. Estimation of the ethylene groups by determining the quantity of standard permanganate required to oxidise the dye-stuffs to aldehydes in cold dilute aqueous solution.

C. Isolation and characterisation of the aldehydes formed.

The results obtained agree with the assumption that in the second stage of transformation condensation takes place between two molecules of the intermediate dinitroso-compound in the following manner:—

$$\begin{array}{l} CH{\cdot}C_6H_3(SO_3Na){\cdot}NO \\ 2\| \qquad\qquad\qquad \rightarrow \\ CH{\cdot}C_6H_3(SO_3Na){\cdot}NO \end{array}$$

$$\rightarrow \begin{array}{ll} CH{\cdot}C_6H_3(SO_3Na){\cdot}N{=}N{\cdot}C_6H_3(SO_3Na){\cdot}CH & \\ \| \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \| & \\ CH{\cdot}C_6H_3(SO_3Na)NO_2 \quad NO_2{\cdot}C_6H_3(SO_3Na){\cdot}CH{\cdot} & \end{array}$$

The dinitroazodistilbenedisulphonic acid thus produced represents the structure of the greenest yellow of the series. The redder yellows and oranges are formed therefrom by the reduction of the two nitro-groups, first to an azoxy- and finally to an azo-group. The stilbene yellows 8G and 4G were proved to consist almost entirely of sodium dinitroazodistilbenedisulphonate. Direct yellow is less pure, but appears to consist substantially of sodium azoxyazodistilbenedisulphonate. Mikado orange, which could not be obtained entirely pure, gave results which approximate to those required for the diazostilbenedisulphonate.

It appears, therefore, that all the dye-stuffs of the stilbene series are true azo-compounds. Their chromophor being an azo-group, their dyeing properties are now satisfactorily explained. They differ, however, from most other azo-dye-stuffs in the entire absence of auxochrome groups.

181. "*Interaction of Succinic Acid and Potassium Dichromate. Note on a Black Modification of Chromium Sesquioxide.*" By EMIL ALPHONSE WERNER.

When a mixture of finely-powdered potassium dichromate (1 mol.) and succinic acid (6 mols.) is heated, interaction takes place a few degrees above the boiling-point of the acid (181°). A compound having the composition $Cr_4(C_4H_4O_4)_5{,}7H_2O$ is formed, which has not the properties of a chromo-organic acid. It is practically insoluble in water, and on lghition in air leaves a residue of chromium sesquioxide which is black. The chromium hydroxide produced from it by decomposition with sodium hydroxide also leaves a jet-black modification of the sesquioxide after ignition.

182. "*Derivatives of Polyvalent Iodine. The Action of Chlorine on Organic Iodo-derivatives, including the Sulphonium and Tetra-substituted Ammonium Iodides.*" By EMIL ALPHONSE WERNER.

Experiments have been made with the object of ascertaining if organic iodo-compounds other than the immediate derivatives of benzene and its homologues can form addition compounds with chlorine corresponding to the iodoso-chlorides.

Iodothiophen, $C_4H_3IS$ (S : I = 1 : 2), and di-iodothiophen, $C_4H_2I_2S$, m. p. 40°, behave like open-chain compounds; on the other hand, tetraiodopyrrole, $C_4NH{\cdot}I_4$, forms the additive compounds $C_4NH{\cdot}I_4Cl_4$ and $C_4NH{\cdot}I_4Cl_3$ (m. p. 158°).

A few new iodoso-derivatives of benzene have been prepared. By the action of chlorine on the sulphonium and

tetra-substituted ammonium iodides, compounds of the type $RCl{\cdot}ICl_3$ have been obtained, from which the more stable compound of the general formula $RCl{\cdot}ICl$ can be produced either by the action of heat or by treatment with a solution of sodium hydroxide.

The following *compounds* were described and their constitution discussed.

$(CH_3)_3SCl{\cdot}ICl_3$ and $(CH_3)_3SCl{\cdot}ICl$ (m. p. 103°).

$C_2H_5(C_3H_7)_3NCl{\cdot}ICl_3$ and $C_2H_5(C_3H_7)_3NCl{\cdot}ICl$ (m. p. 94°).

$(C_2H_5)C_5H_5NCl{\cdot}ICl_3$ and $(C_2H_5)C_5H_5NCl{\cdot}ICl$ (m, p. 35°).

$(CH_3)_4NCl{\cdot}ICl$ (m. p. 217°) and $(C_2H_5)_4NCl{\cdot}ICl$ (m. p. 98°).

183. "*The so-called 'Benzidine Chromate,' and Allied Substances.*" By JAMES MOIR.

This remarkable substance, which resembles cœrulignone very closely, resulted on mixing solutions of benzidine and chromium trioxide. The author finds that it is the chromate, not of benzidine, but of a complex oxidation product of the latter, which has apparently the formula $C_{60}H_{46}N_{10}$. It behaves like cœrulignone towards sulphuric acid and towards sulphites, giving an intense crimson coloration with the former, and yielding *benzidine-2-monosulphonic acid* with the latter. The colour-base, $C_{60}H_{46}N_{10}$, appears to have resulted from the condensation of three molecules of diphenoquinone-di-imine (*Ber.*, 1905, xxxviii., 1232) with two of benzidine, in somewhat the same manner as dianilinoquinonedianil arises from quinone and aniline. On treating with ammonia, only one molecule of benzidine separated from the $C_{60}$ complex, and by the action of potassium sulphite, three molecules of benzidinesulphonic acid were produced. "Benzidine chromate" contains four molecules of chromic acid, but the author has also prepared a substance containing nearly twice as much chromium, which is either $C_{60}H_{46}N_{10}{\cdot}2H_2Cr_4O_{13}$ or merely diphenoquinone-di-imine sesquichromate, $C_{12}H_{10}N_2 + 1\frac{1}{2}CrO_3$.

By heating 3 : 3'-dibromo-5 : 5'-tolidine with chromic acid, a green homologue of "benzidine chromate" was obtained. Its analysis agrees with the formula $C_{60}H_{28}(CH_3)_{10}N_{10}Br_8 + 9H_2CrO_4$, which would be expected from the constitutional formula put forward by the author for "benzidine chromate."

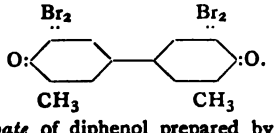
The "ferricyanide of benzidine" has also been investigated. It is similar to and contains the same colour-base as the "chromate," having the formula $C_{60}H_{46}N_{10} + 2H_3Fe(CN)_6$. The action of ammonia resulted in the separation of very little benzidine, giving chiefly another dark colour base and ammonium ferricyanide.

184. "*New Derivatives of Diphenol* 4 : 4'-*Dihydroxdiphenol*)." By JAMES MOIR.

By the sulphonation of diphenol the author has prepared the 3 : 3'-*disulphonic acid*, the 3 : 5 : 3'-*trisulphonic acid*, and the 3 : 5 : 3' : 5'-*tetrasulphonic acid*.

With chlorosulphonic acid, diphenetole yielded (*a*) 4 : 4'-*diphenetole-3-sulphonic acid*, (*b*) 4 : 4'-*diphenetole-3 : 3'-disulphonic acid*, and (*c*) an indifferent *substance* containing chlorine and sulphur.

On brominating Schütz's dinitrodiphenol, a *dibromodinitrodiphenol* melting at 237° was obtained, and from dicresol the 5 : 5'-*dibromodicresol* melting at 185° was prepared; this combines with excess of bromine to form a scarlet substance analogous to tribromophenol bromide, and possessing the constitution—




The *dibenzoate* of diphenol prepared by the Schotten-Baumann method melts at 241°.

185. "*On the Interaction of the Alkyl Sulphates with the Nitrites of the Alkali Metals and Metals of the Alkaline Earths.*" By PRAFULLA CHANDRA RAY and PANCHANAN NEOGI.

By the interaction of the sodium, potassium, barium, and calcium salts of ethyl sulphuric acid and the nitrites of the alkali metals and metals of the alkaline earths, both ethyl nitrite and nitrothane were formed. In the case of potassium ethyl sulphate and potassium or sodium nitrite, small quantities of nitrobutane were also obtained.

186. "*The Electrolytic Preparation of Dialkyldisulphides.*" (Preliminary Note). By THOMAS SLATER PRICE and DOUGLAS FRANK TWISS.

By the electrolysis of a concentrated aqueous solution of ethyl sodium thiosulphate, commonly known as Bunte's salt (*Ber.*, 1874, vii., 646), diethyldisulphide is formed at the anode, and separates as an oily liquid on the surface of the electrolyte. The electrolysis was carried out in a beaker, the cathode consisting of a sheet of platinum-foil lying close to the sides of the beaker, the anode being a piece of stout platinum-wire. The solution contained a quantity of sodium bicarbonate equivalent to the Bunte's salt taken, otherwise the disulphide was decomposed by the sulphuric acid formed during electrolysis, giving the mercaptan. The current density at the anode was 100 ampères per sq. c.m., and the yield was more than 50 per cent of the theoretical. The disulphide obtained distilled almost completely at 152°. It forms a *compound* with silver nitrate, which, on analysis, gave Ag = 36·93. $(C_2H_5)_2S_2,AgNO_3$ requires Ag = 36·95 per cent.

Similar results were obtained by electrolysing solutions of benzyl sodium thiosulphate (Purgotti, *Gazzetta*, 1890, xx., 24), dibenzyldisulphide being produced in a yield of more than 80 per cent; this was crystallised from alcohol, and melted at 70°. Analysis of the *compound* with silver nitrate gave Ag = 26·3. $(C_6H_5CH_2)_2S_2,AgNO_3$ requires Ag = 26·0 per cent.

This reaction is being more thoroughly investigated and extended to the preparation of other disulphides.

187. "*The Direct Union of Carbon and Hydrogen at High Temperatures.*" By JOHN NORMAN PRING and ROBERT SALMON HUTTON.

Previous work has been limited to a study of this reaction at 1200—1350° and to the investigation of the products obtained when a carbon arc is maintained in hydrogen. The authors have now supplemented these observations by working at intermediate temperatures.

For this purpose, a special form of apparatus was devised in which carbon rods, supported at the centre of a glass or metal vessel containing hydrogen, were heated to any desired temperature by the resistance which they offer to the passage of an electric current. By carrying out experiments at gradually increasing temperatures, it was found that traces of acetylene were already formed at 1700°, and the percentage of acetylene increased fairly uniformly with the temperature up to 2800°, which was the maximum point attained. The production of acetylene at these comparatively low temperatures, and independently of any of the complicated electrical phenomena which accompany the arc, does not seem to have been noted previously.

The formation of methane was also carefully studied at temperatures from 1000° upwards; the amounts found were in most cases much below those indicated by Bone and Jerdan (*Trans.*, 1897, lxxi., 41; 1901, lxxix., 1042), and seemed to diminish as the purity of the carbon increased.

188. "*The Action of Nitrogen Sulphide on certain Metallic Chlorides.*" BY OLIVER CHARLES MINTY DAVIS.

When nitrogen sulphide dissolved in dry chloroform is added to the tetrachlorides of tin and titanium, the pentachlorides of antimony and molybdenum, and also tungsten hexachloride dissolved in the same solvent, interaction readily takes place. With stannic chloride, antimony pentachloride, and molybdenum pentachloride, the *compounds* formed are represented by the formulæ $SnCl_4,2N_4S_4$, $SbCl_5,N_4S_4$, and $MoCl_5,N_4S_4$ respectively, but the chlorides of tungsten and titanium are first reduced before combining

with nitrogen sulphide, finally giving *compounds* having the formulæ $WoCl_4,N_4S_4$ and $Ti_2Cl_6,N_4S_4$. These substances are decomposed on exposure to moist air with varying degrees of rapidity, and less readily when preserved beneath dry chloroform. Negative results were obtained with the trichlorides of iron, antimony, and arsenic.

189. "*The Determination of Halogen.*" By JAMES MOIR.

The substance to be analysed having been weighed directly into a tall nickel crucible, ten drops of water and five to seven "pastilles" of pure potassium hydrate are added, and the mixture is stirred with a platinum-wire while it is heated on the steam-bath; when it is uniform, from 0·5 to 1 grm. of finely-powdered potassium permanganate is stirred in, in small portions at a time; the mixture is then heated on the steam-bath until dry, being watched in case frothing occurs; it is afterwards heated slowly to visible redness or until the glowing caused by the interaction between separated carbon and manganese dioxide is over. The cool crucible is placed in a warm dilute solution of potassium bisulphite; the solution is then carefully acidified with acetic acid and filtered directly into a solution of silver nitrate. The silver halide may be worked up with nitric acid in the usual manner, or the cooled crucible may be placed in water and the solution carefully acidified with acetic acid until the manganate is converted into permanganate; the latter is then destroyed by means of barium dioxide, the filtered solution neutralised with sodium bicarbonate and titrated, using chromate as indicator.

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## PHYSICAL SOCIETY.

*Ordinary Meeting, October 26th, 1906.*

Prof. J. PERRY, F.R.S., President, in the Chair.

A PAPER on "*The Strength and Behaviour of Ductile Materials under Combined Stress*" was read by Mr. W. A. SCOBLE.

In former tests of materials under combined stress either the ultimate strength or elastic limit stress has been considered, and the tensions have been applied either directly, or by internal pressure in the case of thin tubes, so that the distribution of stress was approximately uniform. The present experiments were made on bars $\frac{3}{4}$ inch diameter, subjected to bending and twisting to reproduce the irregular distribution of stress occurring in practice. The yield-point was selected as the criterion of strength, but it is open to more than one specification. Here the stress corresponding to the first sign of yield was not taken, but that given by the intersection of the two parts of the stress-strain diagram corresponding to perfect elasticity and complete yield, so that the intermediate state was neglected. The critical bending moment was found to be greater than the yield torque, 2660 and 2400 lbs. ins., and plotting the corresponding bending and twisting moments the ellipse gave the closest approximation to the results. The circular formula $M_e = T_e = \sqrt{M^2 + T^2}$ may be used, taking $M_e$ and the tensile strength if the torque is small, or $T_e$ and the working torsional sheer-stress if the bending moment is small. With both loads on, there was simultaneous yielding in both ways. The maximum principal stress varied considerably, but the maximum shear stress was nearly constant. Usually the bar yielded in the manner corresponding to the fixed load before giving it that due to the increasing load; sometimes the difference in the loads was rather large. The results, together with those of other experiments, were analysed to determine if the variation of the maximum shear stress was due to a force analogous to friction, or the reverse, proportional to the force perpendicular to the plane of maximum shear. It was found that the variation in the values was due to differences in the shear strength in various directions.

Dr. MORROW, in a letter to the Secretary, remarked that he had read Mr. Scoble's paper with great interest, and hoped it would help in removing the obstacles to the application of some theoretical formulæ in design. It was well known that many of the applications of the theory of bending were worse than useless in practice. In cases of combined tension and bending of solid bars (as in crane-hooks, coupling-rods of locomotives, &c.) the usual methods were misleading. In *Proc. Roy. Soc.*, vol. lxxiii., he (Dr. Morrow) described experiments showing that the strains, and hence probably also the stresses, caused by bending rectangular beams were considerably smaller than those given by calculation. Since then the method has been extended to higher stresses in wrought iron and steel bars, but still within the elastic limit. Direct measurements of the longitudinal tensile and compressive strains bear out the previous conclusions. Until it is realised that the ordinary theory of bending is inapplicable to materials of construction (except as a useful approximation when the stresses are low) it will be difficult to arrive at correct conclusions in any problem of combined stress in which bending occurs. Taking some of the results from Mr. Scoble's paper, in which failure was by bending, and assuming that the tensile stress was only $\frac{1}{3}$ of that given by the Euler-Bernoulli theory, Dr. Morrow has drawn up a table which shows that there is nothing to disprove the maximum principal stress theory when the specimen fails by bending. The method adopted is exceedingly rough and does not apply to the very different cases in which failure is by torsion or shearing.

The CHAIRMAN said the paper was a most valuable one, and more scientific experiments upon the subject were required. He could not agree with the notion put forward in many English test-books that the maximum principal stress determined fracture.

A paper by Mr. J. M. BALDWIN on "*The Behaviour of Iron under Weak Periodic Magnetising Forces*" was read by Prof. F. T. TROUTON.

The behaviour of iron in strong alternating fields has been studied by many observers, and the induction in iron when placed in both strong and weak fields has been thoroughly examined by static methods, but up to the present no results have been published of the induction in weak alternating fields. The Author has now, however, succeeded, by means of Lyle's Wave-Tracer (for description of which see *Phil. Mag.*, vol. vi., p. 549), in examining the induction in periodically varying fields down to extremely low amplitudes. The results are in general agreement with what might have been anticipated from work already done by Lord Rayleigh and others in weak fields by statical methods, at least as far as such results can be extended to periodic fields. The method which was used may be shortly described as one in which the wave-curve of the induction is determined by examining the E.M.F. in a secondary coil by means of a commutator arrangement working on the same shaft as a dynamo supplying the primary current to a coil placed on the specimen to be examined. The principal points brought out by Mr. Baldwin's work are as follows:—(1) The permeability satisfies a linear law through a considerable range for weak fields, diminishing to a minimum about 150 as the amplitude of the field diminishes; (2) as the field diminishes the difference in phase between the induction and the magnetising force tends to disappear; and (3) at the same time the hysteresis losses become very small; (4) frequency at these low values of the field has practically no influence on the results obtained.

The CHAIRMAN expressed his interest in the paper and said that twelve or fourteen years ago he worked at the subject in connection with choking-coils, not kinetically, but using the ordinary hysteresis curves. Taking a periodic voltage applied to a choking-coil, it was interesting to note that the iron manufactured harmonics whose frequencies were the odd multiples of the frequency of the fundamental. He contrasted this with the case of trains of mechanism where the frequencies manufactured were always octaves or double octaves of the original frequency.

A paper by Prof. R. W. Wood on "*Fluorescence and Magnetic Rotation Spectra of Sodium Vapour and their Analysis*" was taken as read.

After recapitulating the descriptions of the experimental arrangements given in previous papers, the author describes the work done during the present year in photographing magnetic rotation and fluorescent spectra. A 12-foot grating, a specially constructed three-prism spectrograph, and a monochromatic illuminator were used. The sources of light employed were:—Quartz arc-lamps, containing cadmium, zinc, and thallium; ordinary arcs between lead, zinc, silver, bismuth, and copper electrodes; lithium, sodium, and barium arcs; and vacuum tubes containing helium and hydrogen. After each exposure the D lines were recorded on the photographic plate for purposes of comparison. Some observations on the fluorescence produced by cathode rays are also described. Details are given of the difficulties and special features of the spectra obtained, and directions are indicated for future work.

## CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxliii., No. 15, October 8, 1906.

**Succinic Pinacone.**—Louis Henry.—The author investigates the methods by which succinic pinacone, $(H_3C)_2—\underset{\underset{OH}{|}}{C}—CH_2—CH_2—\underset{\underset{OH}{|}}{C}—(CH_3)_2$, is prepared, and finds that the easiest method—the one with the best yield—is by the reaction of magnesium methyl bromide, $H_3C.Mg.Br$, on ethyl levulate, $H_3C—CO.CH_2.CH_2.CO(OC_2H_5)$. He then investigates its properties, and finds it to be a tertiary alcohol in two senses and contains the two components, $—\overset{|}{C}(OH)$, in the $\gamma$-position separated by a bicarbonate system, $—\overset{|}{C}—\overset{|}{C}—$. When heated, it partially dehydrates, a non-saturated tertiary alcohol resulting, of formula $(H_3C)C=CH—CH_2—\underset{\underset{CH}{|}}{C}(CH_3)_2$.

**Liquefaction of the Starch of Grains.**—A. Boidin.—The author continues his investigation on the influence of phosphates on the viscosity of starch, and he applies his results to the industry of distillation. The amyl matters are heated with the necessary quantity of acid to convert the alkaline polybasic phosphates into monobasic phosphates, and the fluid starch thus obtained is saccharified by the addition of a small quantity of saccharifying medium.

No. 16, October 15.

**Chemical Functions of Textiles.**—Léo Vignon.—The author has already shown that if silk, linen, and cotton are immersed in alkaline, acid, or saline liquors of known composition, placed in a calorimeter, certain constant and measurable thermic phenomena take place. The numbers show that linen and silk possess acid and basic functions, whilst cotton only has very slight acid functions. The author's further researches prove:—(1) That animal textiles have acid and basic chemical functions; (2) that vegetable textiles have no basic functions and possess comparatively feeble acid functions; (3) that porous bodies, as pulverised wood carbon, are inert from a chemical point of view. He also finds that the acid or basic chemical activity of textiles increases with the dilution of the aqueous solution.

**Condensation of Acetylenic Nitriles with Amines. General Method of Synthesis of $\beta$-Substituted $\beta$-Amino-substituted Acrylic Nitriles.**—Ch. Moureu and I. Lazennec.—The acetylenic nitriles, $R—C\equiv C—CN$, unite directly with the primary and secondary amines, giving $\beta$-substituted $\beta$-amino-substituted acrylic nitriles, $R—\underset{\underset{N=}{|}}{C}=CH—CN$. These are neutral bodies, easily hydrolysed by acids, with formation of $\beta$-ketonic nitriles, $R—CO—CH_2—CN$, and regeneration of the amines. This indirect method of fixation of water on to the acetylenic liaison is new and very curious. The authors propose to generalise it.

## MISCELLANEOUS.

**Royal Institution.**—A General Monthly Meeting of the Members of the Royal Institution was held on the 5th inst., The Duke of Northumberland, K.G., President, in the Chair. The Special Thanks of the Members were returned to Dr. Albert P. Brubaker for his present of a portrait of the late Dr. Tyndall, and to Mr. Hugh Spottiswoode for a gift of apparatus.

**Royal Society.—Award of Medals.**—The Royal Society's Medals have this year been adjudicated by the President and Council as follows:—The Copley Medal to Professor Elias Metchnikoff for the importance of his work in zoology and in pathology; the Rumford Medal to Professor Hugh Longbourne Callendar for his experimental work on heat; a Royal Medal to Professor Alfred George Greenhill for his contributions to mathematics, especially the elliptic functions and their applications; a Royal Medal to Dr. Dukinfield Henry Scott for his investigations and discoveries in connection with the structure and relationships of fossil plants; the Davy Medal to Professor Rudolf Fittig for his investigations in chemistry, and especially for his work in lactones and acids; the Darwin Medal to Professor Hugh de Vries on the ground of the significance and extent of his experimental investigations in heredity and variation; the Hughes Medal to Mrs. W. E. Ayrton for her experimental investigations on the electric arc, and also upon sand ripples. The King has been graciously pleased to approve of the award of the Royal Medals. The Medals will, as usual, be presented at the Anniversary Meeting on St. Andrew's Day (Nov. 30). The Society will dine together at the Whitehall Rooms on the evening of the same day.

## MEETINGS FOR THE WEEK.

Tuesday, 13th.—Faraday Society, 8. "Investigations Relative to the Depreciation of Electrolytically produced Solutions of Sodium Hypochlorite," by W. P. Digby. "The Hermite Electrolytic Process at Poplar," by C. V. Biggs. "Electro-chemistry of Lead," by A. C. C. Cumming.

Thursday, 15th.—Chemical, 8.30. "Determination of the Rate of Chemical Change by Measurement of Gases Evolved," by F. E. E. Lamplough. "Xanthoxalanil and its Analogues," by S. Ruhemann.

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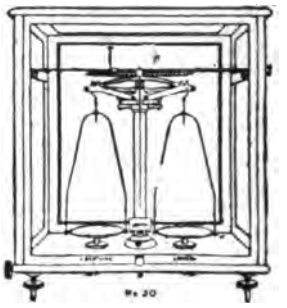

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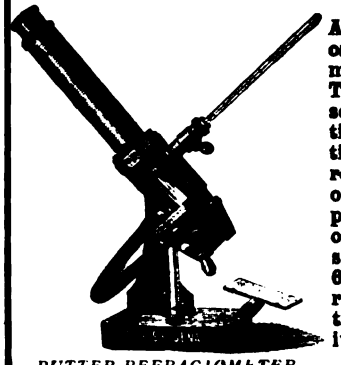

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THE CHEMICAL NEWS.

VOL. XCIV., No. 2451.

# THE COMPOSITION OF THORIANITE, AND THE RELATIVE RADIO-ACTIVITY OF ITS CONSTITUENTS.*

By E. H. BÜCHNER, Ph.D.

*Prefatory Note by Sir William Ramsay.*

WHEN the cubical mineral from Ceylon, sent to me by Mr. Holland in December, 1903, and named by Professor Dunstan "Thorianite," was analysed by several of my students, it was evident that although in the main—as shown by the analysis made by Dr. T. A. Henry under Professor Dunstan's supervision—it consisted of the oxides of thorium and uranium, its composition is by no means simple. The analyses referred to were made by Dr. R. D. Denison, by Mr. Gimingham, and by Mr. Le Rossignol; they are given in Table I. (for convenience of reference Dr. Henry's analyses are also appended).

The extraction of radiothorium by Dr. O. Hahn, "Jahrb. f. Radioaktivität," 1905, vol. ii., and various other investigations carried on in my laboratory, made it evident that under the heading "lead," for example, various other metals were included, and Dr. Büchner undertook to carry out an analysis on a larger amount, so as to ascertain what elements were present in the analytical groups into which the constituents of the mineral had been roughly divided by previous analysts. Another of the objects of his research was to determine how the radio-activity of thorianite is distributed over its various constituents. Assuming, as looks more than probable, that the radio-active constituents of thorianite, like those of similar radio-active minerals, are in process of change, it is to be expected that by working on comparatively large quantities, these bodies and their products can be identified, even though in themselves they may not display the property of radio-activity.

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The methods employed in the chemical analysis of thorianite, together with the results obtained, will form the first section of this account, and the second part will deal with experiments relating to the radio-activity of the several fractions into which the mineral was separated.

The total quantity of mineral taken for analysis was 24·373 grms. On treatment with concentrated boiling nitric acid the greater part of it dissolved. After decantation, the residue was once more boiled with fresh acid, and only a small quantity remained insoluble. The solutions were then mixed. evaporated to dryness, heated to 130° to render any silica present insoluble, and re-dissolved in dilute hydrochloric acid. The residue, which was dried, ignited, and weighed, was non-volatile on treatment with hydrofluoric and sulphuric acids; on testing it, it proved to be zirconium oxide, which had separated out as a basic salt.

Sulphuretted hydrogen was then passed through the hot liquid; the precipitated sulphides were treated with a solution of sodium sulphide, in which a portion dissolved. The residue dissolved almost completely in dilute nitric acid, only a trace remaining, which was soluble in aqua regia; after excess of acid had been removed by evaporation it was dissolved in water, and could be re-precipitated by sulphuretted hydrogen. Its amount, however, was too small to prove undoubtedly that it was mercuric sulphide; mercury, however, has been found (by Miss Evans) in residues from a larger amount of mineral.

Sulphuric acid was added to the nitric acid solution, and the precipitated lead sulphate was filtered off, dried, and weighed.

Ammonia was then added to the filtrate; this should have precipitated bismuth as hydroxide; the colour of the precipitate, however, was reddish brown, and it was practically insoluble in hydrochloric acid; its quantity was also too small to permit of further investigation.

Copper was then precipitated by Rivot's method by addition to the filtrate of ammonium sulphocyanide, after reduction with sulphurous acid. The filtrate from the cuprous sulphocyanide gave traces of a brown precipitate with sulphuretted hydrogen, not in the least resembling cadmium sulphide.

The solution of the sulphides in sodium sulphide, which should have contained arsenic, antimony, and tin, and other elements capable of forming sulpho-salts, was analysed according to the methods of Bunsen and Clarke. A large excess of sulphurous acid was added to the liquid, and it was boiled for a long time. Arsenic is dissolved, antimony and tin remain behind. The insoluble residue was then suspended in water; ammonium persulphate and oxalic acid were added, and sulphuretted hydrogen was once more passed through the solution. After a repetition of this operation, the solution should have contained only antimony, and the residue, tin. The antimony sulphide, after excess of sulphur had been removed by carbon disulphide, had an almost black colour, probably due to the presence of selenium, which has been discovered by Professor Ogawa in this laboratory, in course of work on larger quantities of residue.

The solution, which was supposed to contain arsenic, was treated with sulphuretted hydrogen; to the precipitate, after solution and oxidation, ammonia and magnesia mixture were added, but no arsenate came down. On passing sulphuretted hydrogen, however, a small quantity of a black substance was precipitated.

To the filtrate from the sulphuretted hydrogen group ammonia was added after oxidation. The precipitate was re-dissolved in hydrochloric acid, and, after adding a little concentrated nitric acid, a solution of oxalic acid was poured into the solution. The oxalates of the rare earths separated in a granular state, and were separated by filtration. This precipitate was then treated, according to Brauner's method, with a solution of 20 grms. of ammonium oxalate in 40 grms. of water, and boiled for about ten minutes; the liquid was then diluted with about 800 c.c. of water. The thorium remains in solution; the ceria, &c., are precipitated. This process was repeated, and the solution was then evaporated to dryness and ignited; the thorium oxide was then weighed. The original solution in hydrochloric acid, however, still contained thorium and cerium; it was, therefore, partly evaporated and neutralised with ammonia, and oxalic acid was again added; the precipitate obtained was treated in the same way as has been already described. No attempt was made to separate ceria from the other earths, though they were present, as is proved by the red-brown colour of the $Ce_2O_3$.

The ammonia group further contained iron, aluminium, and uranium, which are not precipitated by oxalic acid. They were separated by the usual methods; if the solution contains excess of ammonium carbonate, only iron and aluminium are precipitated by ammonium sulphide, and uranium is left in solution; after precipitation by evaporation, and re-solution in dilute hydrochloric acid, it was thrown down by ammonium hydroxide and weighed as $U_3O_8$. The aluminium and iron were separated by treatment with excess of caustic potash.

The filtrate from the ammonia group was evaporated to dryness in a platinum basin, and the ammonium salts were expelled; the residue dissolved almost entirely in hydrochloric acid (residue $\omega$; see experiments on radio-activity). After neutralisation of the excess of hydrochloric acid, calcium oxalate was precipitated; the filtrate was again evaporated, and heated to redness. A residue was left,

* A Paper read before the Royal Society, November 8, 1906.

TABLE I.

| | Denison. | Gimingham. | Le Rossignol. | Dunstan and Henry. 1. | 2. | 3. |
|---|---|---|---|---|---|---|
| Thorium oxide, $ThO_2$ .. .. .. | | | | 72·24 | 76·22 | 78·86 |
| Cerium oxide, $Ce_2O_3$? .. .. .. | | | | 6·39 | | |
| Lanthanum oxide, $La_2O_3$ .. .. | 76·4 | 77·52 | 77·07 | 0·51 | 8·04 | 1·02 |
| Didymium oxide, $Di_2O_3$ .. .. .. | | | | | | |
| Uranium oxide, $U_3O_8$ .. .. .. | 14·9 | 13·23 | 12·95 | 11·19 | 12·33 | 15·10 |
| Ferric oxide, $Fe_2O_3$.. .. .. .. | 6·1 | 2·79 | 2·77 | 1·92 | 0·35 | 0·46 |
| Lead oxide, PbO .. .. .. .. | 2·0 | 3·42 | 2·41 | 2·25 | 2·87 | 2·59 |
| Calcium oxide, CaO . .. .. .. | — | — | — | — | — | 1·13 |
| Zirconium oxide, $ZrO_2$ .. .. .. | — | — | — | 3·68 | | |
| Loss on ignition .. .. .. .. | — (*a*) | 1·63 | 1·63 | — | — | 0·20 |
| Helium, He .. .. .. .. .. | — | — | — | — | — | 0·39 |
| Residue on fusion with $HKSO_4$ .. | 0·7 | 2·02 | 2·60 | 0·41 | 0·12 | — |
| | 100·1 | 100·61 | 99·43 | 98·59 | 99·93 | 99·75 |

(*a*) Ignited mineral analysed.

TABLE II.

| | Per cent. | Total activity. | Activity per 10 m.grms. | Activity (mineral = 100). | | |
|---|---|---|---|---|---|---|
| | | *Soluble Portion.* | | | | |
| HgO .. .. .. | Traces | 284 | Not weighed | | | |
| PbO.. .. .. .. | 2·42 | 7206 (Feb. 6)<br>8360 (Feb. 27)<br>9570 (March 23) | 125<br>145<br>166 | 1·9 | 2·2 | 2·5 |
| CuO.. .. .. .. | 0·08 | 10 | | | | |
| $SnO_2$ .. .. .. | 0·05 | None | | | | |
| $Sb_2O_4$ .. .. .. | 0·11 | 16 | | | | |
| $Bi_2O_3$? .. .. .. | 0·21 | 2153 | 414 (Feb. 8)<br>421 (March 24) | — | 0·6 | |
| $As_2O_3$? .. .. .. | Traces | 72 | | | | |
| CdO? .. .. .. | Traces | | | | | |
| $Fe_2O_3$ .. .. .. | 2·05 | 17,530 (Feb. 13)<br>21,380 (March 5) | 351<br>428 | 4·6 | 5·7 | |
| $Al_2O_3$ .. .. .. | 0·15 | None | | | | |
| $U_3O_8$ .. .. .. | 13·12 | 24,915 (Feb. 15)<br>35,490 (April 6) | 78<br>111 | 6·6 | 9·4 | |
| $ThO_2$ .. .. .. | 70·96 | 216,190 | 125 | | 57·2 | |
| $Ce_2O_3$ .. .. .. | 1·96 | 8680 (Feb. 16)<br>9650 (March 28) | 178<br>198 | 2·3 | 2·6 | |
| $ZrO_2$ .. .. .. | 0·23 | 924 | 165 (Feb. 8)<br>163 (March 28) | | 0·2 | |
| CaO.. .. .. .. | 0·13 | 1080 (Feb. 14)<br>1225 (March 27) | 343<br>388 | 0·3 | 0·3 | |
| Residue .. .. .. | 1·50 | 6590 | — | | 1·8 | |
| | | *Insoluble Portion.* | | | | |
| HgO .. .. .. | Traces | 49 | | | | |
| $Bi_2O_3$? .. .. .. | 0·15 | 124 | 44 and 16 (*a*) | | | |
| CdO? .. .. .. | Traces | | | | | |
| $Fe_2O_3$ .. .. .. | 1·30 | 664 (Feb. 13)<br>1010 (March 13) | 21<br>32 | 0·2 | 0·3 | |
| $Al_2O_3$ .. .. .. | 0·06 | None | | | | |
| $U_3O_8$ .. .. .. | 0·02 | 21 | 40 | | | |
| $ZrO_2$ .. .. .. | Traces | | | | | |
| $TiO_2$ .. .. .. | 0·45 | None | | | | |
| Unknown substance | 0·040 | 66 | | | | |
| $P_2O_5$ .. .. .. | Traces | None | | | | |
| $CO_2$.. .. .. .. | 0·10 | | | | | |
| He .. .. .. .. | 0·15 | | | | | |
| $H_2O$.. .. .. .. | 3·20 | | | | | |
| | 98·84 | | | 75·7 | 80·3 | |

Original mineral .. .. .. .. .. .. 155
Standard uranium oxide .. .. .. .. 186

(*a*) This precipitate came down in two portions, which were filtered off and kept sepante; the first had the smaller activity.

which was weighed, and submitted to several tests. Part of it dissolved on boiling with concentrated hydrochloric acid; the solution was evaporated, diluted with water, and treated with excess of caustic soda; the resulting precipitate was soluble in hydrochloric acid. After neutralisation, sodium phosphate gave a white precipitate ($\varphi$); on addition of ammonia to the filtrate, another precipitate came down in very small quantity (magnesia). The solution, which contained excess of soda, was evaporated and heated; on dissolving in water, a residue was left, soluble in hydrochloric acid, and precipitable by hydrogen sulphide with a brownish red colour. None of these precipitates have been investigated more closely.

The portion of the mineral, insoluble in nitric acid, was fused with hydrogen potassium sulphate; the fused mass dissolved almost completely in hot water; on addition of a little hydrochloric acid, however, a precipitate was formed. After this had been removed by filtration, a further quantity of a white substance separated. Sulphuretted hydrogen was passed through the filtrate from this second precipitate, when a red-brown precipitate was thrown down, which was treated in the same manner as described for the soluble part of the mineral. Mercury was again present in traces, as well as substances which came down in place of bismuth and cadmium; these were probably identical in nature with those found in the other portion. After the supposed cadmium had been filtered off, the solution was evaporated and heated; a residue was left ($\rho$). The ammonia group consisted only of aluminium, iron, and uranium. To the filtrate from this group ammonium carbonate was added; no precipitate came down, until after twenty-four hours, when a white substance separated. The filtrate left no residue after it had been evaporated and heated.

The precipitate mentioned above, which was obtained by adding hydrochloric acid to the solution of the fused mass, was once more fused with bisulphate, and dissolved in hot water (solution $\gamma$); a residue remained, which was partly soluble in concentrated hydrochloric acid (solution $\alpha$), and a white residue was left. Sulphuretted hydrogen was then passed through solution $\alpha$, and after twenty-four hours standing, a brownish red precipitate was formed, the filtrate from which was mixed with solution $\beta$, obtained in the following way:—The solution $\gamma$ had become turbid, and deposited a white precipitate; this was removed by filtration. Sulphuretted hydrogen was passed through the filtrate, and gave a precipitate similar in appearance to that formed in solution $\alpha$; after filtering and allowing to stand, saturated with sulphuretted hydrogen for twenty-four hours, another quantity of what was apparently the same substance was obtained. The mixed solutions $\alpha$ and $\beta$ were then oxidised, precipitated with ammonium hydroxide, and the precipitate dissolved in dilute hydrochloric acid. No precipitate was produced with ammonium oxalate, but only a slight turbidity, which passed away on addition of a few more drops. The oxalic acid was removed from this solution by evaporation and ignition, and the oxide was weighed. Qualitative tests showed that it consisted of oxide of titanium with traces of oxide of zirconium.

A separate quantity of the mineral was heated to redness, in order to determine the loss on ignition. It proved to be considerable, and chiefly due to the presence of water. The gas evolved was collected over mercury, and the carbon dioxide absorbed with caustic potash; the only other gas present was helium. From 1 grm. of the mineral 8·2 c.c. of helium were obtained at normal temperature and pressure.

The results of the analysis are given in Table II., where the measurements of radio-activity of the various precipitates are also given, contrasted with that of the mineral taken as 100.

For determining the radio-activity of the precipitates, a month was allowed to elapse after they had been obtained; about 10 m.grms. of the substance, if as much was available, was weighed out and placed in an electroscope. It was sometimes necessary, however, to place precipitate and filter together in the electroscope. The time in which the leaf moved over 20 divisions of the scale was noted, and from this the number of divisions per hour was calculated, allowance having been made for one hour's leakage, had exactly 10 m.grms. been placed on the copper plate. The figures thus obtained are given in the third column of the table, and in the second column the activity of the total quantity of the precipitate, obtained by multiplying the numbers in the third column by the weight of the substance, is recorded. The last column shows the percentage activity, that of the original mineral being taken as 100.

The mineral possesses 83·3 per cent of the activity of standard uranium oxide, a sample several years old. It is also to be noticed that the activity is associated almost entirely with the soluble part of the mineral; while the ratio of the weights of the soluble to the insoluble portion is 40 to 1, the ratio of the activities is about 300 to 1. Again, comparing the activity of constituents common both to the insoluble and soluble portions, such as iron oxide, and bismuth (?) oxide, the samples from the soluble portion are much more active than those of the insoluble portion. In the case of iron the ratio is 17 to 1.

Nearly all the precipitates obtained from the soluble portion proved to be radio-active, although some had only a very slight effect on the electroscope. A remarkable exception is furnished by the alumina, which, although closely allied to the strongly active iron group, is absolutely inactive. The active constituent of the iron group is therefore insoluble in excess of caustic potash; as further experiments showed, it gives off an emanation, the rate of decay of which, although not accurately determined, appears to point to its being due to that of radiothorium, separated by Hahn, which always comes down with iron ("Jahrb. f. Radioaktivität,", 1905, vol. ii.).

The activity of several precipitates had not reached a maximum at the last measurement; those of lead, iron, uranium, cerium, and calcium were still increasing, while the activity of bismuth (?), thorium, and zirconium did not change. On the other hand, several precipitates showed activity originally, which decreased and even disappeared, *e.g.*, $\omega$, insoluble in hydrochloric acid* (see above). When originally obtained, it was placed in the electroscope along with its filter, and showed an activity of 30,000 to 40,000. After destroying the filter, and dissolving the precipitate with aqua regia, and evaporating the solution to dryness, the activity had decreased to 250, and it seemed then to be permanent at that value. It may be assumed, therefore, that this precipitate is a so-called X-substance; its chemical behaviour somewhat resembles that of a platinum metal. After evaporation, the solution in aqua regia left a yellow crystalline residue, which turned black when gently heated. This black residue was insoluble in hydrochloric acid, but soluble in aqua regia; the solution showed again the same properties.

The next most active precipitate was found in the filtrate from the ammonia group. Several very active minute traces of substance were collected on filters. The substance $\phi$, mentioned above, obtained by addition of sodium phosphate, weighed only 8 m.grms., and had a total activity of 3400, which increased to 3900 after standing for six weeks. Although this precipitate forms only 0·02 per cent of the total weight of the mineral, it possesses 1 per cent of the total activity. In connection with this it may be remembered that Rutherford (*Chem. Soc. Trans.*, vol. lxxxi., p. 345) during his early experiments on thorium and thorium-X, also found a strongly active constituent in his thoria, precipitable by sodium phosphate after removal of the thoria. He was not always able to detect it, however, and ascribed it to the presence of an impurity in commercial thoria.

In conclusion, it is my pleasant duty to express my hearty thanks to Sir William Ramsay for his kind assistance and advice.

* The residue, $\rho$, was also initially very active, but lost its activity in a short time.

## A REVISION OF THE ATOMIC WEIGHT OF CADMIUM.*

By GREGORY PAUL BAXTER, MURRAY ARNOLD HINES, and HARRY LOUIS FREVERT.

(Continued from p. 225).

*Method of Analysis* (continued).

From the corrected weight of the cadmium bromide very nearly the requisite quantity of pure silver was calculated. This silver was weighed out and dissolved, in a flask provided with a column of bulbs to prevent loss of silver by splattering, in re-distilled nitric acid diluted with an equal volume of water. After the silver was dissolved, the solution was diluted to twice its volume, and was heated until free from nitrous fumes. Then it was still further diluted until not stronger than 1 per cent, and was slowly added, with constant stirring, to the 1 per cent solution of cadmium bromide in the precipitating flask. In three analyses (4, 5, and 8), this procedure was varied by adding the bromide to the silver nitrate. After being shaken for some time, the solution was allowed to stand several days, with occasional shaking, until the supernatant liquid was clear. Thirty c.c. portions of the solution were then tested with hundredth normal solutions of silver nitrate and sodium bromide in the nephelometer (Richards and Wells, *Am. Chem. Journ.*, 1904, xxxi., 235) for excess of bromide of silver, and, if necessary, either standard silver nitrate or sodium bromide solution was added, and the process of shaking and testing repeated, until the amounts of bromide and silver in the solution were equivalent. If the solution was perfectly clear when tested, and contained no considerable excess of bromide or silver, the test solutions were discarded, since they contained only negligible amounts of dissolved silver bromide; otherwise they were returned to the flask and a correction was applied for the silver bromide thus introduced.

As soon as the exact end-point of the titration had been found, about 4 centigrms. of silver nitrate in excess were added, to precipitate dissolved silver bromide, and the flask was again shaken and allowed to stand until clear. The precipitate of silver bromide was collected upon a weighed Gooch crucible, after it had been washed by decantation about eight times with pure water. Then it was heated in an electric air-bath, first for several hours at 140°, finally for an hour at 200°, and, after it had cooled in a desiccator, it was weighed. In order to determine how much moisture was retained by the precipitate, in each case it was transferred as completely as possible to a clean porcelain crucible and weighed; then the salt was fused by heating the small covered crucible, contained in a large crucible, and again weighed. After fusion the silver bromide was light yellow, with only a trace of darkening, showing that no appreciable reduction had taken place. The asbestos mechanically detached from the Gooch crucible, together with a minute quantity of silver bromide which occasionally escaped the crucible, were collected from the filtrate and wash-waters upon a small filter, the ash of which was treated with nitric and hydrobromic acids before weighing. Although the filtrates and first wash-waters were essentially free from dissolved silver bromide, the subsequent wash-waters usually contained a trace of this substance. The amount of dissolved salt was determined with the nephelometer by comparison with standard bromide solutions. Finally, the weight of silver bromide was corrected for the sodium bromide introduced.

Although in our analyses of cadmium chloride no evidence could be obtained of appreciable occlusion of either cadmium or silver salts by silver chloride, especial precautions were taken to avoid any possibility of such a difficulty in this research. In the first place both the cadmium bromide and the silver nitrate solutions were extremely dilute during precipitation, each one having a volume of about 1 litre. In the second place the method of precipitation was varied by sometimes adding the silver nitrate to the cadmium bromide (Analyses 1, 2, 3, 6, and 7), and sometimes adding the bromide to the silver (Analyses 4, 5, and 8). And in the third place the solutions were allowed to stand varying lengths of time before the titration was completed, so that occluded substances might have opportunity to be dissolved. Analysis 1, in which the largest quantity of bromide was employed, over 11 grms., which is to be expected to give the most marked evidence of occlusion, was not tested for five days after precipitation, and the titration was completed eight days later. In the other analyses the period between precipitation and the completion of the titration varied from seven days in Analysis 4 to three days in Analysis 8. Furthermore, in some cases, after the end-point had been reached, the solutions were allowed to stand some days longer with occasional testing. No change in end-point with standing was observed. In spite of these differences in the method of procedure, the variations in the final results do not exceed the experimental error to be expected, except in the case of Analyses 4 and 12. Evidently, occlusion of any sort must have been very slight if it existed at all. Analyses 4 and 12, performed with the same bromide, differ so markedly from the others that, although no reason for the difference is known, they are rejected in computing the final average.

The gold-plated brass weights were carefully standardised to hundredths of a milligrm. Vacuum corrections of +0·000090 for cadmium bromide, of +0·000046 for silver bromide, and of −0·000031 for silver were applied. (The specific gravity of cadmium bromide has recently been found to be 5·192; Baxter and Hines, *Am. Chem. Journ.* 1904, xxxi., 220). All weighings were made by substitution with counterpoises as nearly like the objects to be weighed as possible. The atomic weight of silver is assumed to be 107·930 and that of bromine to be 79·955.

The analytical work was performed wholly by Mr. Hines.

The ratios of silver used to silver bromide obtained in the same analyses afford sufficient proof of the purity of the bromine and silver, as well as confirmatory evidence of the absence of appreciable occlusion by the silver bromide.

| | Ag : AgBr. |
|---|---|
| Analyses 1 and 9 .. .. .. .. | 57·4444 |
| „ 2 „ 10 .. .. .. .. | 57·4464 |
| „ 3 „ 11 .. .. .. .. | 57·4436 |
| „ 4 „ 12 .. .. .. .. | 57·4436 |
| „ 5 „ 13 .. .. .. .. | 57·4421 |
| „ 6 „ 14 .. .. .. .. | 57·4438 |
| „ 7 „ 15 .. .. .. .. | 57·4428 |
| „ 8 „ 16 .. .. .. .. | 57·4429 |
| Average .. .. .. | 57·4437 |

The most probable value for this ratio has been shown both by Stas and by experimenters in this laboratory to be 57·4445 (Richards, *Proc. Am. Phil. Soc.*, xliii., 119).

In recent experiments in fusing manganous chloride, in a current of hydrochloric acid gas which had been dried by concentrated sulphuric acid and finally by means of phosphorus pentoxide, an insoluble residue of manganous phosphate was invariably obtained when the salt was dissolved in water. The quantity of this residue varied with the amount of moisture contained by the salt when brought in contact with the hydrochloric acid gas, being extremely slight if the salt was very nearly dry, but amounting to several m.grms. if the salt still contained much of its crystal water. Although it seemed certain that the phosphorus had its origin in the phosphorus pentoxide, and was volatilised in the form of either phosphorus pentachloride or oxychloride through the action of the hydrochloric acid upon the pentoxide, in order to obtain still more positive evidence that this was really the case, the experiment was tried of passing hydrochloric acid gas which had been dried

* From the *Journal of the American Chemical Society*, xxviii., No. 6.

THE ATOMIC WEIGHT OF CADMIUM.

(Ag = 107·930. Br = 79·955.

| | No. of analysis. | Sample of $CdBr_2$. | Weight of $CdBr_2$ in vacuum (grms.). | Weight of residue (grm.). | Loss in weight of boat (grm.). | Weight of Ag in vacuum (grms.). | Weight of Ag added or subtracted (grm.) | Corrected wt. of $CdBr_2$ (grms.). | Corrected weight of Ag (grms.). | Atomic weight of cadmium. |
|---|---|---|---|---|---|---|---|---|---|---|
| Series I. $CdBr_2 : 2Ag$. | 1. | II.*a* | 11·46220 | 0·00008 | 0·00004 | 9·08409 | −0·00030 | 11·46216 | 9·08379 | 112·468 |
| | 2. | II.*b* | 6·82294 | 0·00018 | 0·00006 | 5·40734 | −0·00010 | 6·82282 | 5·40724 | 112·461 |
| | 3. | II.*a* | 6·75435 | 0·00011 | +0·00004 | 5·35297 | −0·00020 | 6·75420 | 5·35277 | 112·465 |
| | 4. | III.*a* | 7·08590 | 0·00006 | 0·00004 | 5·61567 | +0·00030 | 7·08588 | 5·61597 | 112·449 |
| | 5. | III.*a* | 5·13867 | 0·00008 | 0·00000 | 4·07236 | −0·00010 | 5·13859 | 4·07226 | 112·473 |
| | 6. | III*a*. | 5·84328 | 0·00008 | 0·00004 | 4·63092 | −0·00020 | 5·84324 | 4·63072 | 112·471 |
| | 7. | III.*a* | 5·99712 | 0·00008 | 0·00000 | 4·75269 | −0·00010 | 5·99704 | 4·75259 | 112·472 |
| | 8. | II.*a* | 5·90811 | 0·00017 | 0·00002 | 4·68200 | 0·00000 | 5·90796 | 4·68200 | 112·472 |
| | | | | | | Average, rejecting Analysis 4.. .. .. .. .. | | | | 112·470 |

| | No. of analysis. | Sample of $CdBr_2$. | Weight of $CdBr_2$ in vacuum (grms.). | Weight of residue (grm.). | Loss in weight of boat (grm.). | Weight of AgBr in vacuum (grms.). | Loss on fusion (grm.). | Weight of asbestos from filtrate (grm.). | Weight of AgBr from washwaters (grm.). | Corrected wt. of $CdBr_2$ (grms.). | Corrected wt. of AgBr (grms.). | Atomic weight of cadmium. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Series II. $CdBr_2 : 2AgBr$. | 9. | II.*a* | 11·46220 | 0·00008 | 0·00004 | 15·81286 | 0·00024 | 0·00024 | 0·00033 | 11·46216 | 15·81319 | 112·466 |
| | 10. | II.*b* | 6·82294 | 0·00018 | 0·00006 | 9·41251 | 0·00028 | 0·00044 | 0·00000 | 6·82282 | 9·41267 | 112·469 |
| | 11. | II.*a* | 6·75435 | 0·00011 | +0·00004 | 9·31815 | 0·00028 | 0·00043 | 0·00000 | 6·75420 | 9·31830 | 112·460 |
| | 12. | III.*a* | 7·08590 | 0·00006 | 0·00004 | 9·77557 | 0·00013 | 0·00053 | 0·00052 | 7·08588 | 9·77649 | 112·444 |
| | 13. | III.*a* | 5·13867 | 0·00008 | 0·00000 | 7·08897 | 0·00007 | 0·00043 | 0·00000 | 5·13859 | 7·08933 | 112·461 |
| | 14. | III.*a* | 5·84328 | 0·00008 | 0·00004 | 8·06076 | 0·00005 | 0·00033 | 0·00026 | 5·84324 | 8·06130 | 112·467 |
| | 15. | III.*a* | 5·99712 | 0·00008 | 0·00000 | 8·27321 | 0·00012 | 0·00020 | 0·00031 | 5·99704 | 8·27360 | 112·463 |
| | 16. | II.*a* | 5·90811 | 0·00017 | 0·00002 | 8·15022 | 0·00015 | 0·00037 | 0·00026 | 5·90796 | 8·15070 | 112·463 |
| | | | | | | Average, rejecting Analysis 12 .. .. .. .. .. | | | | | | 112·464 |
| | | | | | | Average of Series I. and II. .. .. .. .. .. | | | | | | 112·467 |

thoroughly by means of sulphuric acid, first over phosphorus pentoxide which had been freshly sublimed in a current of dry air, and then into water. The aqueous solution, upon evaporation and testing with ammonium molybdate gave a considerable amount of the characteristic ammonium phosphomolybdate. This result confirms that of Bailey and Fowler (CHEMICAL NEWS, lviii., 22), who have found that both hydrochloric and hydrobromic acids react with phosphorus pentoxide at ordinary temperatures to form the oxychloride and bromide of phosphorus respectively. The manganous phosphate, then, must have been produced by the action of the volatilised chloride of phosphorus upon the moisture contained by the manganous chloride to form phosphoric acid, and subsequent displacement of hydrochloric acid from the salt by the phosphoric acid.

Although in our previous work with cadmium chloride, where the double cadmium ammonium chloride, $CdCl_2NH_4Cl$, was fused in a current of hydrochloric acid gas which had been finally dried with phosphorus pentoxide, the salt, which contains no crystal water, was essentially free from moisture before coming in contact with the hydrochloric acid, yet it seemed desirable to repeat the experiments with cadmium chloride in such a way that the danger mentioned above could be completely avoided. This result was easily attained by drying the hydrochloric acid gas with concentrated sulphuric acid only, four columns about 30 c.m. in length, filled with beads moistened with sulphuric acid, being used for the purpose.

In order to ascertain whether concentrated sulphuric acid is appreciably attacked by hydrochloric acid gas, a large quantity of this gas was conducted through the columns and then into water. The aqueous solution was then evaporated and tested for sulphate with barium chloride. Although a slight precipitate of baric sulphate was produced, the quantity was estimated by comparison in a nephelometer with a standard solution of a sulphate to be less than five-hundredths of a milligrm. Evidently nothing is to be feared from this source.

The material for these experiments was prepared from a portion of Fraction II. of cadmium sulphide by first depositing the metal electrolytically from the sulphate, as previously described, and then dissolving the washed cadmium in pure hydrochloric acid in a platinum dish. The chloride does not lend itself readily to crystallisation from aqueous solution, on account of its great solubility even at low temperatures, but by conducting hydrochloric acid gas into the solution the much less soluble double salt with hydrochloric acid, $CdCl_2.2HCl.7H_2O$, was formed. The salt was thus crystallised three times with centrifugal drainage, to free it from the trace of sulphates occluded by the metal during electrolysis. Finally, it was dried and freed from hydrochloric acid as far as possible in a vacuum desiccator containing solid potassium hydroxide.

In Analysis 18 the same specimen of silver was used as in Analyses 4 to 8. In Analyses 17 and 19 a new specimen, which had been twice electrolysed, was employed.

The fusion, bottling, and analysis of the salt were conducted exactly as described in the previous paper on cadmium chloride, and also in this paper. A very slight insoluble residue in the cadmium chloride was determined as in the case of the bromide. The vacuum correction, +0·000156, was applied to every apparent grm. of cadmium chloride, and of +0·000075 for every apparent grm. of silver chloride. (The specific gravity of cadmium chloride has already been found to be 4·047; Baxter and Hines, *Am. Chem. Journ.*, 1904, xxxi., 220). The analytical work was performed by Mr. Hines.

(To be continued).

# PROCEEDINGS OF SOCIETIES

## CHEMICAL SOCIETY.

*Ordinary Meeting, November 1st, 1906.*

Prof. R. Meldola, F.R.S., President, in the Chair.

The President referred to the loss sustained by the Society through the death, on October 19th, of Geh. Rath Professor Fedor Beilstein, who was elected an Honorary and Foreign Member on February 1st, 1883.

Messrs. H. R. Cooper, F. E. E. Lamplough, and W. H. Rawles were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Richard Abegg, Ph.D., Landberstrasse 4, Breslau, Germany; William Heath Bayliss, Brewery House, Ashwell, Herts; Charles George Edgar Farmer, 16, Herbert Crescent, S.W.; David Paton Grubb, B.Sc., Windsor Hill, Newry; John Hamer, 44, Sugden Road, Clapham Common, S.W.; Alexander Edmund Middleton, 112, South Park Road, Wimbledon, S.W.; Arthur Higgs Morris, 77, Beverly Road, Bolton, Lancs.; Arthur Percival Newton, B.Sc., Red Cot, Coulsdon, Surrey; Benjamin Dawson Porritt, 33, South Park Hill, South Croydon; Herbert Stanley Redgrove, 137—140, Tottenham Court Road, W.; William R. R. Starling, 23, Magdalen Road, Norwich.

Of the following papers, those marked * were read:—

*190. "*A Development of the Atomic Theory which Correlates Chemical and Crystalline Structure and Leads to a Demonstration of the Nature of Valency.*" By William Barlow and William Jackson Pope.

The authors represent atoms in the combined state by "spheres of influence," and inquire how such spheres can be close-packed in a homogeneously symmetrical manner so as accurately to simulate crystalline compounds. An examination of the geometrical properties of close-packed assemblages of spheres shows that the atoms of the elements must be represented by spheres of influence directly proportional in volume to their fundamental valencies, and that a close-packed assemblage built up of spheres of the appropriate sizes, so as to represent some particular compound, can be partitioned into units identical with the chemical molecule, and possesses symmetry and dimensions compatible with those of the crystalline substance.

A detailed inquiry concerning benzene, triphenylmethane, naphthalene, anthracene, and their derivatives, shows that, with the inclusion of the above assumption, all the requisite data are available for precisely determining the configuration of the benzene molecule. The configuration deduced is in accordance with the crystallographic and chemical evidence, and leads to an explanation of the meta-, ortho-, para-law of substitution, and of other previously unexplained features of the chemistry of aromatic substances.

In addition to the geometrical property, which demonstrates that valency is a volume relation, it is shown that close-packed homogeneous assemblages of spheres possess others which lead to simple physical interpretations of multivalency and tautomerism. It is also indicated that ethylenic and acetylenic bonds and isomerism have complete analogues in peculiarities of homogeneous assemblages of spheres.

The relations briefly indicated above have been worked out in detail, and are shown to be in entire agreement with the quantitative evidence afforded by the crystallographic measurements of the compounds concerned.

### Discussion.

Prof. Armstrong, after expressing his opinion that the communication was one of altogether fundamental importance, in the first place referred to it as showing the extreme value to chemists of the study of crystallography—a subject of which hitherto relatively far too little notice had been taken. It was to be hoped that a sense of proportion would begin to prevail, and that the study of form would now receive proper attention. The success with which the authors appeared to have correlated crystalline form with structure was very remarkable, especially their determination of the manner in which water or other complexes became attached in one particular direction to a molecule—slabwise. Perhaps the most important feature of the communication and the most interesting to chemists, at present, was the manner in which valency was accounted for as a volume property, and a very ingenious explanation given of varying valency. In particular, he had been struck, when discussing the work with Professor Pope, by the explanation which was given of the departure from the ordinary law of increase or decrease of valency by two units at a time (the law of odd or even valency) observed in the case of the simpler compounds of an element—as in the oxides of nitrogen, for example. Hitherto, chemists had been forced to deal with variation of valency simply as a fact; they were now, for the first time, presented with an explanation of the cause of variation and of the manner in which this was effected.

Another point of extreme interest was the view put forward that it could not be supposed that elements preserved a constant "atomic volume," since it was often found, in cases in which the introduction of a radicle involved an alteration in volume, that the complex changed as a whole, the original form being preserved, alteration taking place proportionally along each axis.

Like the theory of structure at present in use, the mode of treatment now advocated did not enable us to deal with the dynamical side of chemical phenomena; it was to be regarded as an amplification of that theory, not as overriding it or as proving it to be in any way inconsequent. The opportunities it afforded of discussing problems which had eluded our grasp hitherto appeared to be very numerous.

Mr. John Castell-Evans asked whether he had rightly understood Professor Pope's statement relative to the substitution of two or more spheres for one? As he understood it, Professor Pope seemed to say "that if from a closely packed aggregation of spheres one individual sphere of volume *m* be removed, the resulting cavity could be filled by *m* spheres each of unit volume and the 'close packing' be still preserved." This is not the case; if a cube, say, be described about the sphere of volume *m*, then into this cube *m* unit spheres could be packed, but certainly not into the cavity left by the removal of the original sphere.

Mr. Baly pointed out that the particular assemblage of atoms adopted by Professor Pope for the benzene molecule would only exist in the benzene crystal. In the liquid state the molecule of benzene would probably not exist in the rigid condition pictured by the authors; there would seem to be no doubt that the molecule possesses an inherent tendency to vibrate, this tendency being dependent very largely on the temperature. Probably the melting-point of a crystal marks the temperature at which the tendency to vibrate on the part of the molecules overcomes the elastic energy of the crystalline form. Inasmuch as the reactions of benzene and its compounds usually take place with the substance in solution or in the liquid state, any property based only on the rigid structure in the crystal would not necessarily hold good. For example, the authors base an explanation of the ortho-, meta-, and para-substitution on this rigid structure. Owing to the dynamic condition obtaining during reactions this explanation would seem to fall to the ground.

Mr. Woolhouse expressed surprise that in the complex $NaNO_3$ the element C with a volume of 4 could replace the N with a volume of 3, and that the element Ca with a volume of 2 could replace the Na with a volume of 1, and yet calcite could have such a similarity of crystalline form, as it is known to have, to that of sodium nitrate.

Although the replacement of N by C might leave the

$x$, $y$, $z$ ratios the same in spite of the increase of each, still the substitution of Ca for Na must result in an alteration of shape of the complex, resulting in the increase of at least one of these values.

Prof. MIERS, speaking as a crystallographer, stated his conviction that the new theory propounded by the authors was destined to be of immense value in the problems of crystal structure.

Crystallographers were accustomed to treat these as statical problems, and (largely owing to the researches of Mr. Barlow) feel fairly confident that they now know something of the manner in which the crystalline material is arranged. The principle of packing was liable to suspicion so long as there was no clue to the nature of the units, but had now acquired quite a new meaning with the valency volumes to indicate the dimensions of the bodies to be packed: so that we might now hope to realise a true model of the crystal structure.

The case of the Humite group, in which the increase of an axis is absolutely proportional to the valency volume of the introduced radicle, was in his opinion a very convincing one. The theory was one of profound interest to all students of crystals.

Dr. TUTTON said that he considered a notable advance had been made by the authors of this paper, which furnished another example of the advantages of the study of crystallography by chemists, an object which he had long been striving to further. There appeared to be three salient points in the work, the results of which were laid before the Society that evening. The first was the emphasis of the individual influence of the atom as distinguished from the properties of the molecule as a whole, and the influence of certain predominating atoms in particular in determining those properties. This had been one of the chief results of his (Dr. Tutton's) own work on the sulphates and selenates, and the present work was based on that now absolutely incontrovertible foundation. The second point was that the teaching of the "topic axial ratios," introduced to the Society by him (Dr. Tutton) in the year 1894, simultaneously with and independently of Dr. Muthmann in the *Zeitschrift für Krystallographie*, was now advanced by the authors of the present paper a step further, inasmuch as in the formulæ for those ratios the term V respecting the molecular volume would now be replaced by W, the valency volume. Not only did this involve the remarkable geometrical explanation of valency which had been explained to them, but, and this was the third point which the speaker desired to emphasise, it enabled the ratios in question to be no longer confined to exhibiting in a highly instructive manner the structural relationships between the members of the same series of isomorphous compounds, but connected various series together, and indeed, in general, enabled comparisons to be made between compounds of totally dissimilar, as well as of similar, nature. It was therefore obvious that a great advance in the correlation of chemical composition and crystalline form had been made.

Mr. W. BARLOW pointed out that the spheres employed to picture the equilibrium conditions of the atoms must not be regarded as actually existent in nature; the actual spheres of influence of the atoms are not supposed to be separated by interstices, and the models are merely the best means that the authors have found for expressing, in a concrete form, the results of their researches. The balls used to represent the atomic spheres of influence should be made of solid soft indiarubber, so as to be elastic and deformable, but not compressible, and the close-packed assemblages, composed of balls of appropriate sizes, should be compressed to an extent which will practically annul the interstices.

Prof. POPE said that in the substitution referred to by Mr. Evans, the interstitial space is regarded as available for occupation by the new contents of the cavity. The total space available for the substituting spheres is thus not spherical, but of the irregular shape bounded by the curved surfaces of the enveloping spheres.

The series of substitutions as a result of which the $NaNO_3$ assemblage is converted into that of $CaCO_3$ can be performed so that the crystalline form changes but slightly, although the equivalent parameters $x$, $y$, and $z$ increase, but remain equal to one another in accordance with the rhombohedral symmetry.

It is not claimed that the rigid assemblage of solid spheres represents accurately the condition of crystalline benzene; the spheres of atomic influence may well be regarded as domains of considerable dynamic activity. The existence of "liquid crystals" suggests that much symmetry of arrangement occurs transiently in liquids generally, and the uniformity of chemical reaction in solution must be largely attributable to symmetry of arrangement as between reacting molecules. There is no reason to suppose that considerable change in molecular configuration attends the liquefaction of benzene; as the suggested mode of regarding the meta- and ortho-para-law only postulates symmetry of arrangement, it appears to be perfectly valid.

191. "*Synthesis of Carvestrene.*" (Preliminary Notice). By WILLIAM HENRY PERKIN, jun., and GEORGE TATTERSALL.

When *m*-hydroxybenzoic acid is reduced by means of alcohol and sodium, it is converted into hexahydro-*m*-hydroxybenzoic acid,—

$$CH_2<\begin{matrix}CH(OH)\cdot CH_2\\ CH_2\text{———}CH_2\end{matrix}>CH\cdot CO_2H,$$

which crystallises from ether, and melts at 130—132° (compare Einhorn, *Annalen*, 1896, ccxci., 298). Oxidation with potassium bichromate and sulphuric acid converts this hydroxy-acid into *γ-ketohexahydrobenzoic acid*,—

$$CH_2<\begin{matrix}CO\text{—}CH_2\\ CH_2\cdot CH_2\end{matrix}>CH\cdot CO_2H,$$

which had previously been obtained only in the form of a syrup (Baeyer and Tutein, *Ber.*, 1889, xxii., 2182; Einhorn, *loc. cit.*, p. 304; Goodwin and Perkin, *Trans.*, 1905, lxxxvii., 852). It crystallises from benzene in glistening prisms, melts at 75—76°, distils as 210° (25 m.m.), and yields a *semicarbazone* melting at 182—183° with decomposition.

*Ethyl γ-ketohexahydrobenzoate* (b. p. 150° under 30 m.m.) reacts with magnesium methyl iodide with the formation of the *lactone* of *γ-hydroxyhexahydro*-m-*toluic acid*,—

$$CH_2<\begin{matrix}O\text{———}CO\\ CMe\cdot CH_2\\ CH_2\text{—}CH_2\end{matrix}>CH,$$

a colourless oil which distils at 145° (20 m.m.), and when heated with hydrobromic acid is quantitatively converted into *γ-bromohexahydro*-m-*toluic acid*,—

$$CH_2<\begin{matrix}CMeBr\cdot CH_2\\ CH_2\text{—}CH_2\end{matrix}>CH\cdot CO_2H,$$

which, so far, has only been obtained in the form of a syrup. It readily loses hydrogen bromide when treated with pyridine, and is converted into a *tetrahydro*-m-*toluic acid* of boiling-point 142—144° (15 m.m.), which probably has the constitution—

$$CH_2<\begin{matrix}CMe:CH\\ CH_2\cdot CH_2\end{matrix}>CH\cdot CO_2H.$$

The *ester* of this acid (b. p. 128° under 60 m.m.) reacts readily with magnesium methyl iodide, and is almost quantitatively converted into $\Delta^1$-m-*menthenol*(8),—

$$CH_2<\begin{matrix}CMe:CH\\ CH_2\cdot CH_2\end{matrix}>CH\cdot CMe\cdot OH,$$

which had not previously been prepared. This tertiary alcohol distils at 110—112° (30 m.m.), has a pleasant odour of menthol and terpineol, and when digested with potassium hydrogen sulphate is almost quantitatively decomposed with elimination of water and formation of *carvestrene*,—

$$CH_2<\begin{matrix}CMe:CH\\ CH_2\cdot CH_2\end{matrix}>CH\cdot CMe:CH_2.$$

The hydrocarbon thus obtained distilled at 179—180°, and yielded a *dihydrochloride*, $C_{10}H_{16},2HCl$, melting at 52·5°, and a *dihydrobromide*, $C_{10}H_{16},2HBr$, melting at 48°. Its solution in acetic anhydride was coloured deep blue by the addition of sulphuric acid.

Since these properties coincide exactly with those of carvestrene, which Baeyer (*Ber.*, 1894, xxvii,, 3488) first prepared by the distillation of vestrylamine hydrochloride, and which Baeyer and Villiger (*Ber.*, 1898, xxxi., 1402) subsequently proved to belong to the *m*-cymene series, there can be little doubt that the above experiments are to be regarded as a synthesis of this important terpene.

(To be continued).

## NOTICES OF BOOKS.

*Report on the Advancements of Pharmaceutical Chemistry and Therapeutics.* Vol. XIX. Darmstadt: E. Merck. 1906.

These Reports on the Advancements of Pharmaceutical Chemistry and Therapeutics are sent gratis to medical men and others interested in pharmacology on application to 16, Jewry Street, E.C. Although the compiler has an interest in the manufacture of many of the preparations which he discusses at length, the report is sufficiently impartial to be worthy of attention as a work of reference, and no new preparation is overlooked if it appears to be really valuable. Moreover, information is given, with copious references to original papers, regarding fresh uses of well-known drugs, besides full details of cases which have exhibited specially interesting features.

*Petroleum and its Products.* By Sir Boverton Redwood, D.Sc., &c. Second Edition. London: Charles Griffin and Co., Ltd. 1906.

The new edition of this standard work is in every respect an admirable treatise on the occurrence, properties, production, and uses of petroleum, and nobody who takes a scientific or practical interest in any of the numerous branches of the great industry can afford to be without a copy. The work now occupies two volumes, for although it has been found possible to condense some portions, the advance of knowledge has necessitated considerable additions to various chapters. Many new maps and figures are included, and, moreover, a complete bibliography has been added; the preparation of this last section, which occupies nearly a quarter of Volume II., must have been a formidable piece of work, but it will undoubtedly be greatly appreciated. The author has had the advantage of valuable assistance from some of the most eminent authorities on the geological and geographical distribution of petroleum and natural gas, and on the practical methods of the production and refining of petroleum, and he has brought his treatise to such a state of excellence as to enable it to compare favourably with most works in any language.

*Nitro-Explosives.* By P. Gerald Sanford, F.I.C., F.C.S. Second Edition. London: Crosby Lockwood and Son. 1906.

In the second edition of a treatise on a rapidly growing branch of science the reader expects to find full information relative to its most recent developments, and in this case he will not be disappointed, for the revision of the first edition has been very thoroughly performed. The chapter on smokeless powder, for instance, has been greatly enlarged, and many details of composition and manufacture are now included which did not find a place in the earlier edition. A critical examination of the book for deficiencies regarding modern processes and practice has brought to light only one omission which can be regarded as of importance, and this relates to the freezing-point determinations of nitro-glycerin. Nauckhoff's work on the subject is abstracted and reviewed, but no mention is made of recent research on dinitro-glycerin, which seems to be a suitable substance for dissolving in nitro-glycerin to lower the freezing-point, and for the manufacture of which Mikolajczak not long ago patented a process. The features of the book, which did so much to recommend the earlier edition, namely, the systematic arrangement and the thoroughly practical treatment of all nitrated substances, are still conspicuous in the second edition, which is a valuable contribution to the literature of nitro-explosives.

*General Principles of Organic Syntheses.* By P. Alexeyeff. Authorised Translation by J. Merritt Matthews, Ph.D. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1906.

This volume is based upon a monograph which was published as long ago as 1899 by the late Professor Alexeyeff, of the University of Kieff. The translator has worked in much new material, and has made extensive alterations, so that the English edition is more than a mere translation of the Russian original. It will be found most useful in co-ordinating the knowledge of the advanced student who has already some acquaintance with the elements of organic chemistry, and with its help he cannot fail to widen his views and strengthen his grasp of a subject which sometimes appears to present a bewildering mass of unorganised details. The plan of the book is to group together general methods employed in organic chemistry —such as oxidation, reduction, fixation and removal of radicals, condensations, &c.—and to consider them from a theoretical point of view, generalising and explaining the choice of various reagents for different purposes. No practical details relating to the apparatus, &c., to be employed are given, for the book is intended, not to replace, but to supplement a laboratory manual; it deserves to be well received by teachers and advanced students, and those engaged in research work will gather useful information from it.

*Technologie der Fette und Ole.* ("Technology of Fats and Oils") By Gustav Hefter. Vol. I. Berlin: Julius Springer. 1906.

The author of this treatise has observed that, while the last two decades have seen the publication of several works on the analysis of fats, no book devoted exclusively to the technology of the fat industry has appeared, although monographs on various branches have been issued. To supply this want of a comprehensive modern work on the oil and fat industries has been his special aim. The occurrence, constituents, and properties of the natural oils, fats, and waxes are treated comparatively briefly, while the general methods of extraction are discussed more fully; different processes and apparatus are described with copious illustrations and plans. Although, naturally, special prominence is given to German practice, English, American, and French methods all find a place in the book, which will be the more useful, both in Germany and other countries, on account of this cosmopolitan policy. The by-products of the industries are fully treated, as regards both properties and utilisation; for instance, the manufacture of oil cakes is discussed, data concerning their average composition, price, &c., being given. The whole is very carefully indexed, and will be a valuable addition to the library of the manufacturer and chemist.

*Cours de Chimie Organique.* ("Course of Organic Chemistry"). By Fréd. Swarts. Paris: A. Hermann. 1906.

In this book the course of lectures on organic chemistry delivered by the author at the University of Gand is reproduced, with somewhat fuller treatment of parts of the subject, of which time did not allow an extended discussion

in the lectures. The book is occupied more with descriptive and theoretical organic chemistry than with practical work, and the theory of the science is particularly well treated. The author goes systematically through the most important classes of fatty and aromatic compounds, thus providing a very good elementary course, although there appear to be no special novelties of treatment to notice. Some technical processes are introduced, and attention is paid to industrial applications, while general methods of preparation are specially emphasised. A useful feature is the introduction of theoretical discussions at convenient points in the text, which should help the beginner to obtain a good grasp of the theory of organic chemistry, the logical method of first discussing facts and then basing theories upon them being far the most successful way of presenting the subject.

## CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxliii., No. 17, October 22, 1906.

**Existence of Bromine Chloride.**—Paul Lebeau.—The author's investigations lead him to the conclusion that the compound hitherto known as bromine chloride does not exist, the constant composition of the mixture being due to the circumstances of its formation. In fact, it corresponds to the solubility of chlorine in bromine at the temperature of 0°. No other combinations take place by the direct action of chlorine on bromine. The crystals which are obtained by sufficiently cooling a solution of bromine in liquid chlorine have a composition depending on their temperature of formation, and they are proved to be merely mixed crystals of chlorine and bromine.

**Cæsium Protoxide.**—E. Rengade.—It is possible to prepare well-defined cæsium protoxide in a perfectly pure crystalline condition by evaporating a solution of the oxide in an excess of cæsium. It is thus obtained in the form of orange-red crystals, which react violently on water and decompose at about 500° when in contact with silver and in the cold when in contact with liquefied ammonia. In the latter case, the protoxide is transformed into a mixture of amide and hydrate of cæsium. The formula of the protoxide is found by estimating the cæsium and measuring the oxygen used in the experiment ($Cs_2O$). The author is also preparing, by the same method, the oxides of rubidium and potassium.

**Pure Alloys of Manganese and Tungsten, and Preparation of Tungsten Metal.**—G. Arrivant.—By the action of powdered aluminium on a mixture of the oxides of the metals it is possible to obtain alloys of tungsten and manganese rich in tungsten, but their separation is often incomplete, and the author devises a better method. To obtain alloys rich in manganese, he heats a mixture of the powdered metals in a current of hydrogen in a Schlœsing furnace. However, no alloy containing more than 25 per cent of tungsten can be prepared by this method. By reducing suitably selected mixtures of oxides of manganese and tungsten by means of aluminium, the author prepares alloys containing up to 60 per cent of tungsten. These bodies do not appear to contain the metals in a combined state, and when treated with dilute acids they leave a residue of pure tungsten, which method can be used as a means of preparing the metal.

**Condensation Products of Acetylenic Ethers with Amines.**—Ch. Moureu and I. Lazennec.—The products of condensation of the acetylenic ether salts, $R—C\equiv C—CO_2R'$, with amines are non-basic bodies, which can easily be hydrolysed by acids; the hydrolysis causing the amine to form again in addition to the $\beta$-ketonic ether, $R—CO—CH_2—CO_2R'$. This reaction constitutes a new and excellent method of transforming acetylenic ethers into $\beta$-ketonic ethers.

**Atomic Weight of Dysprosium.**—G. Urbain and M. Demenitroux.—The mean of a number of experiments gives the atomic weight or dysprosium as 162·54, the method used being the transformation of the hydrated sulphate of formula $Dy_2(SO_4)_3+8H_2O$ into the oxide, $Dy_2O_3$.

**Presence of Formol in various Foods.**—G. Perrier.—The author investigates the proportion of the minute traces of formol in various food materials.

**Azoic Dyes: Their Heat of Combustion and Formula of Constitution.**—P. Lemoult.—The author finds the heat of formation of a large number of azoic dyes. He finds that, in their actual state, the azoic dyes can be represented with great exactitude as azo-carbides on which are fixed the OH or $NH_2$ groups. Perhaps also, under certain circumstances, quinonisation takes place, but the author is further investigating this latter question.

*Berichte der Deutschen Chemischen Gesellschaft.* Vol. xxxix., No. 12, 1906.

**Atomic Weight of Tantalum.**—F. Willy Hinrichsen and N. Sahlbom.—Marignac determined the atomic weight of tantalum by purifying potassium tantalum fluoride ($K_2TaF_7$) by partial crystallisation, treating it with concentrated sulphuric acid, extracting the potassium sulphate thus formed with hot water, and igniting the residue, which consisted of a mixture of tantalum sulphate and tantalic acid. The $Ta_2O_5$ thus obtained was then weighed, and the potassium sulphate in the filtrate was also determined. The atomic weight was thence calculated to be 183. This method, however, is open to objection; for instance, fluorine is not included amongst those elements whose atomic weights are accurately known, and, moreover, it is very probable that on evaporation with sulphuric acid some of the tantalum passes away as fluoride. The authors have consequently undertaken a new determination. First of all they used potassium tantalum fluoride, but were not satisfied with the results, so fell back upon the conversion of the metal into oxide. Perfectly pure metal foil was cut up into small pieces and ignited in a platinum Rose's crucible in pure oxygen. As the mean of five experiments which agreed well among themselves it was found that Ta = 181·0. According to Bernouilli, an anode of tantalum metal is dissolved in strong alkali solution when an electric current is passed. The authors accordingly tried, by using a suitable silver salt solution in the circuit and comparing the weight of the tantalum dissolved with the weight of the silver separated, to find the equivalent of tantalum. The experiments, however, failed, because at low potentials the tantalum electrode was not attacked, and when the potential was raised, solution took place suddenly and large sparks were formed.

**Titration of Hydrofluosilicic Acid.**—N. Sahlbom and F. Willy Hinrichsen.—The authors have tested for fluorine the waters of the Burtscheid Springs, which contain large amounts of sulphur. They determined the fluorine by titrating the hydrofluosilicic acid formed on treating the silicon fluoride with water. They found that hydrofluosilicic acid is very readily split up hydrolytically in presence of alkalis, forming hydrofluoric acid and silicic acid. If, then, care is taken, by precipitating with alcohol, to remove the potassium or barium salt from the further action of the hydroxyl ions, the acid can be titrated directly as a dibasic acid, according to the equation $H_2SiF_6+2KOH=K_2SiF_6+2H_2O$. If the solution is warmed on the water-bath the titration can be performed with caustic soda without further addition of alcohol. In this case the reaction proceeds according to the equation $H_2SiF_6+6KOH=6KF+Si(OH)_4+2H_2O$. Thus, for every

atom of fluorine one molecule of alkali is used. Phenolphthalein or litmus can be used as an indicator. Employing this method the authors found that the waters examined contain only 0·0008 grm. of fluorine per litre.

**Radio-activity of the Thermal Springs at Aix.**—N. Sahlbom and F. Willy Hinrichsen.—The examination of the radio-activity of the thermal springs was performed with Engler and Sieveking's apparatus. A litre of the thermal waters was used, or 125 grms. of the solid. The radio-activity was exceedingly small, if the water was used hot as taken from the spring. After it had stood for some time the cooled liquid gave rather higher values. Some of the numbers obtained, taking into account the induced activity and the loss of potential on using distilled water, were as follows:—

| 1 litre of water from— | Decrease in volt/hrs. | Remarks. |
|---|---|---|
| 1. Krinolinen Spring (71°) .. | 2 | Straight from the Spring |
| 2. Kaiser Spring (52°) .. .. | 6 | 15 mins. after drawing |
| 3. Krinolinen Spring (cooled) | 20 | 1¼ hours " |
| 4. Kaiser Spring (cooled) .. | 24 | 1 " " |
| 5. Sebastian Spring .. .. | 32 | 2 " " |
| 6. Pocken Springs .. .. | 76 | 2 " " |

The authors also examined the mixtures of salts obtained on evaporating the waters, as well as clay, sinter, and mud. The following values were obtained:—

| Substance (125 grms.). | Volt/hours. |
|---|---|
| 1. Salt from Sebastian Spring .. .. .. | 3·0 |
| 2. Clay from Sebastian Spring.. .. .. | 8·0 |
| 3. Mud from Sebastian Spring.. .. .. | 8 |
| 4. Sinter from Kaiser Spring .. .. .. | 15 |
| 5. Sinter from Burtscheid .. .. .. .. | 30 |
| 6. Mud from Krinolinen Spring .. .. | 70 |
| 7. Mud from Kaiser Spring .. .. .. | 483 |

As the surface of the layer has an important influence on radio-active action, on using smaller quantities a higher value of the decrease of potential was to be expected than when the whole 125 grms. was brought on to the apparatus at once, and thus the parts not on the surface could exert no action on the electroscope. As a matter of fact, an experiment with only 10 grms. of the mud from the Kaiser Spring, which showed the strongest activity, gave a fall of potential of 112 volts per hour. This would give 1400 volts per hour for 125 grms.

**Molecular Weight of Indigo.**—E. Beckmann and W. Gabel.—The reduction of indigo-blue to indigo-red, and thence to indigo-white, and also freezing-point determinations in *p*-toluidine and in phenol, indicate that the molecular weight of indigo is double that of the substance represented by Baeyer's simple formula,—

$$C_6H_4<\begin{smallmatrix}NH\\CO\end{smallmatrix}>C:C<\begin{smallmatrix}NH\\CO\end{smallmatrix}>C_6H_4, = 262.$$

In view of the conflicting evidence upon this point the authors have determined the molecular weight afresh, firstly by means of ebullioscopic experiments, using Beckmann's apparatus, and for solvents quinoline, aniline, phenol, and *p*-toluidine. All the experiments gave as the result the simple molecular weight. The freezing-point experiments were then repeated, using aniline, phenol, and *p*-toluidine; only the last of these gave the doubled molecular weight.

**Quantitative Sublimation of Phosphoric Acid from its Salts.**—P. Jannasch and E. Heimann.—It has been observed that when phosphoric acid is determined by distilling a mixture of phosphate and carbon in a current of chlorine the results obtained are not satisfactory. If, however, an intimate mixture of phosphate and carbon is made by separating the latter from a sugar solution in the distilling flask by means of sulphuric acid, the phosphoric acid distils over quantitatively. This method was first tried with ammonium phosphate, when 99·65 per cent of the phosphoric acid passed over; it was then applied to the determination of phosphates in presence of fixed bases, magnesium phosphate being used, and the results were equally satisfactory, after the distillation had been repeated several times.

**Detection of Alkaline Earths by Means of Spectrum Analysis.**—E. H. Riesenfeld and H. E. Wohlers.—The burner described by the authors in the *Chemiker Zeitung* (1906, xxx., 704) can be conveniently used to detect the alkaline earths. 0·1 to 0·5 grm. of the alkaline earth carbonate precipitate is dissolved in 0·5 to 1·0 c.c. 10 per cent hydrochloric acid and the solution made up to 2 c.c. with water. The current used is 0·2 ampère or with exceedingly dilute solutions 1 ampère. The lines used for the identification are:—

| | | |
|---|---|---|
| Ca | = 622·0 $\mu\mu$ | 553·5 $\mu\mu$ |
| Sr | = 604·5 " | 460·8 " |
| Ba | = 524·2 " | 513·7 " |

To detect calcium and strontium the electrolytic method is more sensitive than the chemical, while in the case of barium the chemical method is to be preferred. The brightness of the lines enables an estimate to be made of the proportions of the metals present. The systematic analysis of the solutions of the carbonates of the alkaline earths is best performed by first examining by spectrum analysis. Even if barium is not detected it may be present in minute quantities, and the solutions must therefore be subsequently examined chemically.

**Determination of Formic Acid with Potassium Permanganate.**—Joseph Klein.—The author calls attention to the fact that he published some years ago details of a method of determining formic acid. By this method, which applies to the acid and its salts, the oxidation with permanganate was effected in boiling solution made feebly alkaline with caustic alkali; the excess of permanganate was decomposed with oxalic acid and dilute sulphuric acid, and the excess of oxalic acid was titrated with permanganate.

**Cobaltic Dioximines**—L. Tschugaeff.—The author has prepared a series of complex compounds by the action of α-dioximes on salts of the metals belonging to the eighth group of the Periodic System. These compounds, which are called dioximines, contain the complex $D_2H_2$ or $2\begin{smallmatrix}R.C:NO.H\\R.C:NO.H\end{smallmatrix}—H_2$. The dioximines of cobalt are very stable; the ammonia molecule of the complex base and its salts $[Co(2NH_3)D_2H_2]X$ can be replaced by a series of organic bases (*e.g.*, methylamine, ethylamine, pyridine), and the resulting compounds are, as regards their properties and chemical behaviour, exactly analogous to the corresponding diamine salts.

**Reactions at Low Temperatures.**—Walter Peters.—Vorländer found when investigating the addition products of hydrochloric acid and unsaturated ketones at low temperatures, that the affinity increases in the cold. The author has now investigated the behaviour of organic bases towards hydrocyanic acid at the temperature of an ether-carbonic acid mixture. One molecule of the base was dissolved in 10 c.c. of absolute ether and rather more than one molecule of hydrocyanic acid in the same quantity of solvent; the solutions were cooled to −70°, and mixed. The resulting precipitate was poured without filtration on a tile over liquid air, and the ether completely drawn off in one-half to two hours. Thus the following cyanides were isolated or at least shown to be capable of existence:—Propyl ammonium cyanide, di-ethyl ammonium cyanide, tri-ethyl ammonium cyanide, di-methyl hydrazinium cyanide, pentamethylene diaminium cyanide, piperidinium cyanide, coniinium cyanide.

**Molecular Weight of Hypophosphoric Acid.**—Arthur Rosenheim, Wilhelm Stadler, and Felix Jacobsohn.—The acid sodium salt of this acid was prepared by immersing bars of yellow phosphorus in a solution of sodium acetate and keeping the whole at a temperature of from 6° to 8°. In six to eight days acid sodium hyphosphate had crystallised out. This was re-crystallised from water

containing acetic acid, and the formula was found to be $NaHPO_3.3H_2O$. The molecular conductivities of a solution of the salt and of a solution of the salt containing an equivalent of sodium hydrate were then determined, and it was observed that $NaHPO_3$ behaves like an acid salt, and that the solution containing caustic soda undoubtedly contained hydroxyl ions. Hence no definite conclusions regarding the basicity of the salt could be drawn from these experiments. From the solidification curve of mixtures of $H_3PO_3$ and $H_3PO_4$ it was found that when phosphorous and phosphoric acid are fused together hypophosphoric acid is not formed, and hence it is probably not a condensation product of these two acids. The molecular raising of the boiling-point was then determined for hypo-phosphoric acid methyl ester and pyro-phosphoric acid ethyl ester, using as solvents ethyl iodide, ethyl bromide, and chloroform, and the results showed that the hypo-phosphoric acid ester has the simple molecular formula $(CH_3)_2PO_3$, and that the acid itself is therefore to be regarded as a derivative of tetravalent phosphorus and not as a derivative of tri- and penta-valent phosphorus with the formula $H_4P_2O_6$. The parallel experiments with the pyrophosphoric acid ester showed that the solvents used behave normally in determinations of the molecular weight of esters.

**Hydrosol of Thorium Oxide Hydrate.**—Arthur Müller.—This hydrosol can be prepared by precipitating thorium hydroxide with alkali from a solution of the nitrate in water, washing the precipitate very carefully to remove all electrolytes, and heating it with water to boiling, meanwhile shaking well. A further portion of the dried nitrate is dissolved in water and added to the hydroxide from a burette, the boiling being continued for five minutes between each addition. Thus a perfectly homogeneous hydrosol is obtained, which is unaltered on boiling. On evaporation of the solution a glittering brittle crust is obtained which swells up on addition of water, and gradually dissolves to an opalescent hydrosol. Thus the change of state is reversible, and the dry residue is the solid hydrosol of thorium hydroxide. The addition of neutral salts does not alter the hydrosol. Alkalis give with it a gelatinous transparent precipitate, and the insoluble hydrosol is also formed by the addition of most acids.

**Compounds of Stannic Sulphate with Sulphates of the Alkaline Earths and with Lead Sulphate.**—R. F. Weinland and Hugo Kühl.—If to a solution of ortho-stannic acid in concentrated sulphuric acid is added a solution of calcium sulphate in the same acid, and the mixture is concentrated by slow evaporation in a porcelain dish, small colourless cubes of $Sn(SO_4)_2.CaSO_4.3H_2O$ separate out. The ortho-stannic acid must be freshly prepared, and the calcium sulphate is best precipitated from boiling calcium chloride solution with dilute sulphuric acid, washed, and used without drying. With strontium, barium, and lead sulphates the stannic sulphate forms corresponding compounds. The salts of the alkali sulphates are more difficult to isolate, and the authors are still engaged in research upon them. The stannic alkaline earth sulphates appear to be stannates the oxygen of which is replaced by $SO_4$:—$SnO_3Ca$, $Sn(SO_4)_3Ca$; they are insoluble in water, and when boiled with water partially decompose, yielding stannic acid and sulphate of the alkaline earth. The calcium and strontium salts dissolve in excess of hot concentrated hydrochloric acid; when the barium salt is boiled with hydrochloric acid all the barium separates out as sulphate and the stannic acid goes into solution.

**Electrolytic Determination of Copper.**—F. Foerster. The author uses for his electrolyte 100 c.c. of a solution of copper sulphate containing 10 c.c. of 2-N sulphuric acid, the cathode being a cylindrical Winkler's wire gauze cathode, and the anode a platinum wire spiral in the axis of the cathode, and a lead accumulator is short-circuited by this bath. No gaseous hydrogen is evolved, and the method is simple and accurate. If the electrolyte is warmed to 70° the separation is greatly hastened; thus with 2 volts in about an hour 0·15 grm. of copper can be quantitatively separated, using a sulphuric acid solution.

**Halogen Salts of Niobium Oxychloride ($NbOCl_3$) and of Niobium Oxybromide.**—R. F. Weinland and Ludwig Storz.—The authors have obtained two series of salts:—(1) $NbOCl_3.RCl$, (2) $NbOCl_3.2RCl$, and the corresponding bromides. To prepare these salts a solution of hydrated niobic acid in hydrochloric or hydrobromic acid, or of niobium oxychloride or pentachloride in absolute alcohol is used. The addition of solutions of quinoline, pyridine, cæsium, and rubidium chlorides in concentrated hydrochloric acid to these solutions gave the following chloro-salts: — $NbOCl_3.C_9H_7NHCl$, $NbOCl_3.C_5H_5NHCl$, &c. The chloro-salts are colourless or faint yellow colour. They crystallise well, the cæsium and rubidium salts regularly. They are decomposed in moist air, giving up hydrochloric acid, and with water they split up, yielding niobic acid. The bromo-salts, which are red in colour, are still more unstable than the chlorides, giving up hydrobromic acid and turning white in moist air. They also are decomposed by water.

**Transference of Oxygen by Burning Potassium.**—K. A. Hofmann and H. Hiendlmaier.—When potassium is fused and burnt in a current of air it is found that almost all materials are strongly attacked. For instance, lead and gold are converted into potassium platinate and potassium aurate; pure silver is comparatively little affected, while copper, iron, nickel, and cobalt are strongly oxidised. If pure potassium is burnt on pure nickel-foil, on cooling a mixture of yellowish brown potassium peroxide with long black prisms is formed. When the mass is introduced into ice-cold water, the potassium peroxide splits up into caustic potash and oxygen, and a black crystalline powder sinks to the bottom. This powder has the composition represented by the formula $Ni_2O_5H_4$. It has a strong oxidising action on organic substances; thus it converts alcohol into aldehyde in presence of sulphuric acid. It is also reduced by cellulose, and therefore cannot be collected on filter-paper without losing some of its oxygen. The constitution appears to be expressed by $NiO_2:NiO+2H_2O$, and the compound is thus a nickelo-nickelite. The authors have also prepared a similar cobalto-cobaltite, $CoO.2CoO_2.2H_2O$. This compound is far more stable than the nickelo-nickelite. It is not attacked by dilute sulphuric acid in the cold, and even the concentrated acid does not liberate oxygen until the substance is heated. Strong hydrochloric acid, however, liberates chlorine.

## MISCELLANEOUS.

**The Fogging of Plates in Tropical Climates.**—Referring to Mr. McDowall's paper in the CHEMICAL NEWS for November 2nd (vol. xciv., p. 209), Dr. W. J. Russell, F.R.S., writes to say that the points mentioned in Mr. McDowall's paper have already been described by him; and even the spoiling of some of the plates used at the last eclipse expedition was explained by him in a letter to *Nature* last December.

**Royal Institution.**—A Christmas Course of Lectures, adapted to a juvenile auditory, will be delivered at the Royal Institution by Mr. W. Duddell, on "Signalling to a Distance—from Primitive Man to Radio-telegraphy" (experimentally illustrated). The dates of the lectures are December 27, 29, 1906, January 1, 3, 5, 8, 1907, at three o'clock.

**Chemical Abstracts of the American Chemical Society.**—In accordance with the recent vote of the Society the publication of a semi-monthly abstract journal will be commenced January 1, 1907. The corps of those in charge of the various divisions of the journal is already

well organised and work upon the abstracts has been commenced. It is intended to include in the Journal abstracts of all new work in chemistry published in the world after October 1, 1906. Chemical patents issued in the United States, Germany, France, and England, after July 1, 1906, will be included. The abstracts will be classified under the following divisions, the selection of abstractors and the oversight of each division being placed in the hands of the persons named:—

Apparatus. W. H. Walker.
General and Physical Chemistry. G. N. Lewis.
Photography. L. H. Friedburg.
Electro-chemistry. W. R. Whitney.
Radio-activity. H. N. McCoy.
Inorganic Chemistry. Alexander Smith.
Analytical Chemistry. L. M. Dennis.
Mineralogical and Geological Chemistry. W. F. Hillebrand.
Metallurgy. J. W. Richards, Henry Fay.
Acids, Alkalis, and Salts. T. L. Briggs.
Glass and Pottery. G. E. Barton, Albert V. Bleininger.
Cements and Mortars. Harry Drew.
Fuel, Gas, Coke. J. D. Pennock.
Organic Chemistry. M. T. Bogert.
Petroleum, Asphalt, Turpentine, Wood Products. S. S. Sadtler.
Cellulose, Paper. A. D. Little.
Explosives. C. E. Munroe.
Dyes, Textile Fabrics, Bleaching, Inks. L. A. Olney.
Pigments, Resins, Varnishes, Indiarubber. A. H. Sabin.
Fats, Fatty Oils, and Soap. W. D. Richardson.
Sugar, Starch, and Gum. C. A. Browne, Jun.
Leather, Glue. J. H. Yocum.
Biological Chemistry. L. B. Mendel.
Foods. W. D. Bigelow.
Nutrition. C. F. Langworthy.
Water, Sewage, Disinfectants, Insecticides. L. P. Kinnicutt.
Fermented and Distilled Liquors. Robert Wahl.
Pharmaceutical Chemistry. A. B. Stevens.
Soils and Fertilisers. F. P. Veitch, J. H. Pettit.
Patents. W. H. Seaman.

The dues of the Society for 1907 will be increased to eight dollars to pay for the expense of the new publication. It is expected that for the first year or two, at least, the cost of the abstract journal will be considerably greater than the increased receipts from dues, and the success of the enterprise depends upon the hearty support of our members in maintaining and increasing the membership of the Society. It is therefore urged that every member of the Society shall make an especial effort to secure an increase in the membership. The abstract journal will be published twice a month. The Journal of the American Chemical Society will, of course, be continued and will contain original articles, book reviews, and reviews of recent progress in the various fields of chemistry. For those who are not members of the Society the subscription price will be as follows:—*Journal of the American Chemical Society*, monthly, six dollars; *Chemical Abstracts*, semi-monthly, six dollars; for both journals, sent to the same subscriber, ten dollars.

## MEETINGS FOR THE WEEK.

Monday, 19th.—Society of Arts, 8. (Cantor Lectures). "Artificial Fertilisers—their Nature and Functions," by A. D. Hall.

Wednesday, 21st.—Microscopical, 8. "Use of a Top Stop for Developing Latent Powers of the Microscope," by J. W. Gordon.

— Society of Arts, 8. Opening Address of the One Hundred and Fifty-third Session, by Sir Steuart Colvin Bayley, K.C.S.I., &c.

Friday, 23rd.—Physical, 5. "On the Electrical Radiation from Bent Atennæ," by J. A. Fleming. "Auroral and Sunspot Frequencies contrasted," by C. Chree. "Electrical Resistance of Alloys," by R. S. Willows.


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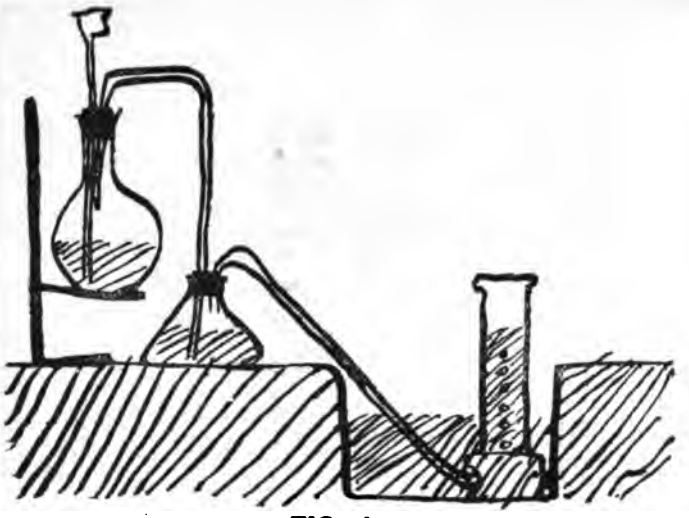

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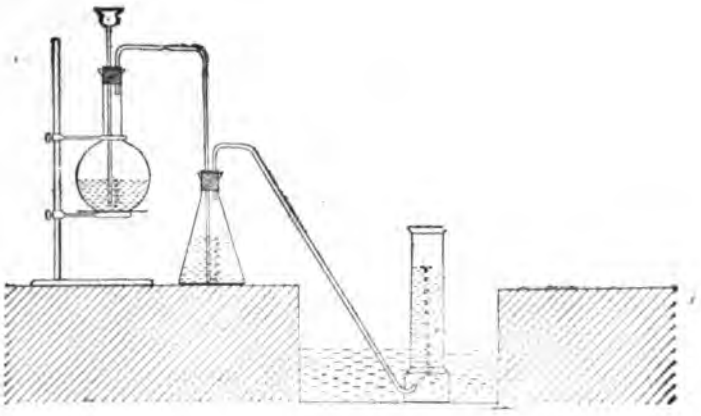

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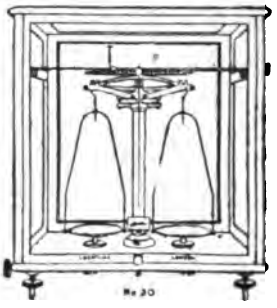

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THE CHEMICAL NEWS.

VOL. XCIV., No. 2452.

## RELATIONSHIP BETWEEN THE ATOMIC WEIGHTS OF ANALOGOUS ELEMENTS.

By E. BRADBURY.

IN the CHEMICAL NEWS of September 28, 1906 (vol. xciv., p. 157), I attempted to show that the properties of the elements and of their compounds are accurately indicated by their specific gravities, and also pointed out that elements grouped together in my classification frequently showed numerical relationships in their atomic weights. In this note I intend to deal with the latter point more fully.

Let W be atomic weight. Then—

$$\frac{W\,Rd}{W\,Ba}=\frac{W\,Ca}{W\,Mg}=\frac{W\,Zn}{W\,Ca}=\frac{W\,Pd}{W\,Zn}=$$

$$=\frac{W\,Pt}{W\,Sn}=\frac{W\,Sn}{W\,Ge}=\left(\frac{W\,Mg}{W\,Be}\right)^{\frac{1}{2}};$$

also—

$$\frac{W\,Pb}{W\,Ba}=\left(\frac{W\,Ba}{W\,Ca}\right)^{\frac{1}{3}}.$$

Similarly—

$$\left(\frac{W\,Pb}{W\,Sr}\right)^{\frac{1}{3}}=\frac{W\,Sr}{W\,Zn}=\left(\frac{W\,Si}{W\,C}\right)^{\frac{1}{3}}=\left(\frac{W\,Sn}{W\,Si}\right)^{\frac{1}{2}}$$

and—

$$\left(\frac{W\,Th}{W\,Pd}\right)^{\frac{1}{2}}=\frac{W\,Pd}{W\,Ge}.$$

Considering the trivalent elements, we get—

$$\left(\frac{W\,Ir}{W\,Cr}\right)^{\frac{1}{2}}=\frac{W\,Cr}{W\,Al};\quad \frac{W\,In}{W\,Fe}=\frac{W\,Fe}{W\,Al};$$

$$\frac{W\,Ta}{W\,Sb}=\left(\frac{W\,Sb}{W\,V}\right)^{\frac{1}{2}};\quad \frac{W\,Ir}{W\,Ce}=\frac{W\,Ce}{W\,Rh}=\frac{W\,Rh}{W\,As};$$

$$\frac{W\,Ta}{W\,In}=\frac{W\,In}{W\,Ga}=\frac{W\,Ga}{W\,Sc}=\frac{W\,Sc}{W\,Al}=\frac{W\,Ir}{W\,Sb}=\frac{W\,Sb}{W\,As};$$

$$\frac{W\,Bi}{W\,Ce}=\frac{W\,Ce}{W\,Nb}=\left(\frac{W\,P}{W\,N}\right)^{\frac{1}{2}}.$$

It is interesting to note that similar relationships exist with radicles, *e.g.*,—

$$\frac{W\,Rb}{W\,K}=\frac{W\,K}{W\,Am};\quad \frac{W\,F}{W\,Cu}=\frac{W\,Cu}{W\,Cl};\quad \frac{W\,N_3}{W\,Br}=\left(\frac{W\,Cl}{W\,I}\right)^{\frac{1}{2}}.$$

Mercury is analogous to Cd and Cu; the following relationships verify it:—

$$\frac{W\,Hg}{W\,Cd}=\frac{W\,Cd}{W\,Cu}.$$

The following ratios, like the foregoing, are, in my opinion, indicative that analogous elements have a common origin:—

$$\frac{W\,O}{W\,S}=\frac{W\,S}{W\,Cu}=\left(\frac{W\,Cu}{W\,Zr}\right)^{2}=\left(\frac{W\,Zr}{W\,Te}\right)^{2}.$$

$$\frac{W\,U}{W\,Mo}=\left(\frac{W\,Mo}{W\,Cr}\right)^{\frac{3}{2}}.\quad \left(\frac{W\,Os}{W\,Zr}\right)^{\frac{1}{2}}=\left(\frac{W\,Zr}{W\,Mn}\right)^{\frac{1}{2}}.$$

$$\frac{W\,W}{W\,Se}=\left(\frac{W\,Se}{W\,Cr}\right)^{2}.$$

Bradbury's School,
16, John Dalton Street, Manchester,
November 9, 1906.

ON THE

## CHEMICAL ACTION OF ULTRA-VIOLET LIGHT.

By W. H. ROSS.

THE work herein described was undertaken with a view to making especially some quantitative measurements on the chemical action of light. Since in the majority of chemical changes the greatest effect is produced by ultra-violet light, it was thought advisable to work with a source of light rich in these rays. Such a source was obtained by causing an oscillatory spark to pass between aluminium terminals joined in the secondary circuit of a large induction coil used as a transformer. In the secondary circuit was also joined in parallel a large Leyden jar. Through the primary circuit was passed an alternating current of 110 volts having a strength of 3·4 ampères. To obtain a constant source of light proved a matter of considerable difficulty. However, by arranging an apparatus as thus described, and having in the primary circuit an ammeter and resistance boxes, the resistance could be changed at will and the strength of the current thus kept constant. When a uniform current was in this way maintained, the amount of energy given out by the spark during intervals of ten minutes was practically constant. This was shown to be the case by the fact that the same amount of iodine was set free from equal volumes of a potassium iodide solution, when exposed to the light under exactly the same conditions for equal intervals of time. After every observation the aluminium terminals were sharpened, and then placed the same distance apart so that every exposure might be begun under the same conditions. The terminals used were large—3 m.m. by 8 m.m. cross-section—and were allowed to rest for the greater part of their length on iron plates placed 7 c.m. apart. In this way the heat generated by the spark was rapidly conducted away. By placing the proper amount of ice in small dishes resting on the terminals, the temperature of a solution of 3 c.c., placed in a cell directly underneath the spark, could be kept within a range of 1° during an exposure of ten minutes.

Aluminium terminals were used on account of the strong ultra-violet rays given out by a spark passing between them. The rate of decomposition produced by the light in the case of the iodides, when terminals of aluminium were used, was found to be at least twice as great as that resulting when terminals of any of the other common metals are used. Cadmium could not be used on account of its softness. An accurate comparison of the decomposition produced, when electrodes of different metals were used, was not made, since, on account of their difference in hardness, the experiments could not be carried out under comparable conditions.

### *Decomposition of the Iodides.*

The compounds first investigated were the iodides of the different metals in solution. The solution to be exposed to the light was placed in a shallow vessel directly underneath the spark. The amount of iodine set free was determined by titrating with a standard solution of sodium thiosulphate, using starch as indicator. When making exposures of ten minutes. the most convenient strength of the sodium thiosulphate was found to be 1/1000 normal. With a solution of this strength the amount of iodine set free could not be determined by titrating with the thiosulphate directly. By adding an excess of the thiosulphate solution, however, and then titrating with a 1/1000 normal solution of iodine, the amount of iodine set free could be accurately determined.

It was noticed when making titrations that the purest water obtainable, that used in this laboratory for making electrical conductivity measurements, had the power of decolorising quite an appreciable amount of iodine. Thus, to 20 c.c. of water, containing a few drops of starch solution, had to be added from 0·2 c.c. to 0·4 c.c. of a

1/1000 normal solution of iodine before any blue colour appeared. With an iodide present a less amount of the iodine solution was required. Hence, before titrating any solution exposed to the light, a blank titration of a solution containing the same amount of iodide was made in every case, in order that the proper correction to be applied might be found.

When a solution of potassium iodide was exposed to the light in an open vessel, the amounts of iodine set free, on making exposure for equal intervals of time, varied greatly. When the distance of the solution from the spark was doubled, the rate of decomposition remained almost the same as before. The spark was then made to pass through an atmosphere of oxygen. This was done by placing the terminals in a large bell-jar filled with the gas. Under these conditions, the rate of decomposition was found to be very much increased. In replacing the oxygen with carbon dioxide, the amount of decomposition resulting in the same length of time was very small. It therefore became evident that the greater part of the decomposition first obtained was produced, not by the light only, but principally by the action of ozone and the oxides of nitrogen formed by the passage of the spark through air.

To determine the effect of the ultra-violet light only, the solution was placed in a small shallow dish provided with a quartz cover. The latter was sealed into a rim of hard rubber, which was in turn surrounded by an elastic rubber band. This then could be slipped over the top of the dish so as to secure the complete exclusion of any gas. When the dish was now placed underneath the spark, the decomposition resulting represented the total effect of the waves of light given out by the spark. By subtracting from this the effect produced when a thick piece of glass plate was interposed between the spark and the solution, the effect of the ultra-violet light alone, or that part of it capable of being absorbed by the glass, was determined. When a photograph of the spectrum given by the spark was taken by means of a spectroscope, it was found that, when the glass plate used in the following experiments was interposed between the spark and the spectroscope, all wave-lengths were absorbed below $\lambda$ 3260.

That the decomposition of the iodide, which took place when gases formed by the spark were excluded, was due to the action of the light alone was shown by varying the distance of the solution from the spark. It was now found that the amount of iodine set free varied inversely as the square of the distance, which one would expect if the decomposition is due entirely to the amount of light energy incident upon the solution. When making exposures, 3 c.c. of the solution were taken in every case, while the time of exposure was ten minutes.

The effect produced on solutions of potassium iodide of different concentrations is shown in the following table:—

| Grm.-mol. KI per litre. | I set free measured in c.c. of N/1000 solution. |
|---|---|
| 3·0 | 3·58 |
| 2·0 | 3·35 |
| 1·0 | 3·00 |
| 0·5 | 2·68 |
| 0·2 | 2·15 |
| 0·1 | 1·85 |
| 0·05 | 1·50 |
| 0·02 | 1·15 |
| 0·01 | 1·00 |
| 0·005 | 0·80 |
| 0·002 | 0·50 |
| 0·001 | 0·40 |

Duplicate observations, which agreed with one another within 0·1 c.c., were made in every case.

On varying the time of exposure, the amount of iodine set free was not at first exactly proportional to the time. This agrees with what might be expected, for the colour of the solution—or its power of absorption—changes after a short exposure. A tenth-normal solution was used in each case.

| Time of exposure. | I set free in c.c. of N/1000 solution. |
|---|---|
| 10 | 1·85 |
| 20 | 3·30 |
| 30 | 4·90 |

When making these observations, the terminals were sharpened and placed the same distance apart every ten minutes.

When the glass plate already referred to was interposed between the spark and the solution the amount of iodine set free was very small. Thus, in the case of a twice normal solution of potassium iodide, the amount set free was found to be equivalent to only 0·15 c.c. of a 1/1000 normal solution of iodine, while in the case of a 1/10 normal solution no free iodine could be detected after an exposure of ten minutes. When working with the more concentrated solution, the amount of iodine set free by the action of the visible light was subtracted from the total amount set free to get the results given above.

The iodides of sodium, lithium, barium, calcium, and zinc were next investigated, but all were found to give the same results as those given by potassium iodide.

| Grm.-equivalents of iodide per litre. | Iodine set free in c.c. of N/1000 solution. | | | | | |
|---|---|---|---|---|---|---|
| | KI. | NaI. | LiI. | $BaI_2$. | $CaI_2$. | $ZnI_2$. |
| 2·0 | 3·35 | 3·40 | 3·35 | 3·45 | 3·37 | 3·40 |
| 0·5 | 2·68 | 2·60 | 2·65 | 2·70 | 2·73 | 2·70 |
| 0·1 | 1·85 | 1·80 | 1·85 | 1·75 | 1·80 | 1·85 |
| 0·01 | 1·00 | 1·00 | 1·05 | 1·00 | 1·03 | 1·00 |

These observations were made at a temperature of 18°. A variation, however, in the temperature of any of the solutions between 15° and 30° produced no appreciable change in the rate of decomposition.

### *Reduction of Ferric Salts.*

Solutions of the sulphate, nitrate, and chloride were standardised by reducing with stannous chloride and then titrating with potassium permanganate in the presence of manganese sulphate and phosphoric acid. That the solutions thus standardised as regards the iron also contained equivalent amounts of acid was shown by titrating a definite portion of each solution with a standard sodium hydroxide solution, using phenolphthalein as indicator.

When two Nessler tubes surrounded with white paper were filled with the standard sulphate and chloride solution, it was noticed that the first solution was slightly darker than the second, but on adding to it a few drops of acid it could be brought to the same colour as the other when thus viewed by reflected light. When the tubes, with the paper coverings removed, were placed so as to view the solutions by transmitted light, the sulphate solution was now much lighter in colour than the chloride solution; this shows that the two solutions have a different power of absorption for light. Hence, when acted upon by light of the same intensity, it was found—as might be expected for this reason alone—that the solutions were not reduced at the same rate.

As is well known, the action of light on ferric salts is very much increased when there is present in solution some organic compound (as cane-sugar) which of itself will not reduce the salts, but does so under the influence of light. Hence, when working with these solutions, a definite amount of sugar was always added.

The amount of salt reduced was determined by titrating with a standard 3/400 normal solution of potassium permanganate. When finding the effect of ultra-violet light on solutions of different strength, a one-fifth normal solution was first taken, to which was added 10 grms. of sugar per 50 c.c. of solution. A one-tenth normal solution was then prepared by adding to a definite volume of the one-fifth normal solution an equal volume of water. Solutions of other dilution were prepared from the one-fifth normal solution in the same way.

With ferric chloride, sulphate, and nitrate the following results were obtained on making exposures of ten minutes.

| Grm.-equivalents of salt per litre. | Ferrous salt formed in c.c. of 3N/400 solution. | | |
|---|---|---|---|
| | $FeCl_2$. | $FeSO_3$. | $Fe(NO_3)_2$. |
| 0·20 | 2·50 | 2·45 | 0·55 |
| 0·10 | 2·25 | 1·70 | 0·50 |
| 0·05 | 1·93 | 1·05 | 0·48 |
| 0·02 | 1·27 | 0·50 | — |
| 0·01 | 0·85 | 0·40 | — |
| 0·005 | 0·70 | — | — |
| 0·002 | 0·60 | — | — |

The amount of sugar added has a considerable effect on the amount of reduction which takes place, as is shown thus:—

| Percentage of sugar added. | $FeCl_2$ formed in c.c. of 3N/400 solution. |
|---|---|
| 10 | 1·73 |
| 20 | 2·50 |
| 40 | 3·22 |

The amount of ferric salt reduced is approximately proportional to the time of exposure. A one-fifth normal solution of ferric chloride containing 10 grms. of sugar per 50 c.c. of solution gave results as follows:—

| Time of exposure (minutes). | $FeCl_2$ formed in c.c. of 3N/400 solution. |
|---|---|
| 10 | 2·53 |
| 20 | 4·70 |
| 30 | 7·15 |

Varying the temperature of any ferric salt solution was found to have a slight effect on the rate of reduction.

*Reduction of Chlorates and Bromates.*

While solutions of the chlorates and bromates are quite stable in sunlight, they were found to be reduced to quite an extent when acted upon by that part of the ultra-violet spectrum capable of being absorbed by glass. The extent of the reduction was determined by titrating the amount of chloride or bromide formed by means of a 1/200 normal solution of silver nitrate. It was found that solutions of all chlorates of the same strength were reduced at the same rate, while the same thing was true of the bromates. The rate of reduction of the chlorates, however, differed from that of the bromates. Unlike the iodides or ferric salts, varying the strength of either the chlorate or bromate solutions from one-half to one-fiftieth normal did not produce any appreciable difference in the amount of reduction which took place.

| Grm.-equivalents of $KClO_3$ [or $NaClO_3$, $Ba(ClO_3)_2$, &c.] per litre. | Chloride formed in c.c. of N/200 solution. |
|---|---|
| 0·50 | 0·80 |
| 0·10 | 0·80 |
| 0·02 | 0·80 |
| 0·01 | 0·78 |

In the case of the bromates the amount of salt reduced was less than in the case of the chlorates. Thus, when the strength of any standard bromate solution was varied from one-half to one-hundredth normal, the amount of bromide formed in every case was equivalent to only 0·25 c.c. of a 1/200 normal silver nitrate solution.

The amount of chlorate or bromate reduced was found to be exactly proportional to time of exposure.

Sugar added to solutions of the chlorates or bromates resulted in an increase in the amount of reduction which took place, but to a much less extent than in the case of the iron salts. Varying the strength of the solution now produced a change in the amount of reduction. A one-half normal solution of potassium chlorate containing 10 grms. of sugar per 50 c.c. of solution, when diluted so as to make a one-twentieth normal solution, gave the same results, however, as one containing no sugar.

| Grm.-mol. of $KClO_3$ per litre. | Chloride formed in c.c. of N/200 solution. |
|---|---|
| 0·5 | 1·50 |
| 0·2 | 1·15 |
| 0·1 | 0·90 |
| 0·05 | 0·80 |
| 0·01 | 0·80 |

When sugar was added to the bromate solutions a greater amount of reduction took place than in the case of the chlorates.

| Grm.-mol. of bromate per litre. | Bromide formed in c.c. of N/200 solution from— | | |
|---|---|---|---|
| | $KBrO_3$. | $NaBrO_3$. | $Ba(BrO_3)_2$. |
| 0·5 | 1·75 | 1·73 | 1·75 |
| 0·2 | 1·55 | 1·50 | 1·55 |
| 0·1 | 1·40 | 1·42 | 1·37 |
| 0·05 | 1·20 | 1·20 | 1·25 |

Before making a titration to determine the amount of change produced in any particular solution, a blank titration was first made in every case.

I wish to express my thanks to Professors Jones and Wood, at whose suggestion this work was undertaken.—*Journal of the American Chemical Society*, xxviii., No. 6.

## THE IODOMETRIC DETERMINATION OF ALUMINIUM IN ALUMINIUM CHLORIDE AND ALUMINIUM SULPHATE.

By S. E. MOODY.

A PROCESS for the gravimetric determination of alumina in salts of aluminium has been described by Stock (*Ber.*, 1900, xxxiii., [i.], 548), who bases the method upon the reaction represented by the following equation:—

$$Al_2(SO_4)_3 + 5KI + KIO_3 + 3H_2O = 2Al(OH)_3 + 3K_2SO_4 + 6I.$$

This equation would show that iodine is liberated when potassium iodate and potassium iodide are together added to a solution of aluminium sulphate. It was found, however, that in the action of the iodide-iodate mixture upon a solution of potassium alum, only about two-thirds of the iodine corresponding to the aluminium salt is accounted for; and this suggests that the reaction is not completed according to the equation, and that the precipitate formed is not the simple hydroxide. Upon ignition the precipitate yields, however, the total amount of alumina present; and, since the character of the precipitate is good, the process is easily managed, and gives, as Stock has said, an excellent gravimetric method for the determination of alumina.

Taking aluminium chloride, $AlCl_3 \cdot 6H_2O$, and proceeding in the same manner, similar results are obtained, and after dissolving the precipitate in sulphuric acid and adding silver nitrate to the dilute solution, a decided precipitate of silver chloride is observed, which upon washing, drying, and weighing is found to be about one-third of the amount of that substance corresponding to the original aluminium chloride. This indicates that it is an oxychloride which is formed on the addition of potassium iodide and iodate; moreover, upon removing by sodium thiosulphate the iodine first set free in the action and allowing the mixture to stand, progressive hydrolysis takes place as shown by the return of colour due to iodine, and this change can be still further hastened by heating after adding an excess of sodium thiosulphate to take up the iodine as liberated. The attempt was made therefore to complete the reaction between the iodide-iodate mixture and the aluminium chloride, or alum, by heating the solution in a Voit flask through which steam or, still better, hydrogen was passed, as an aid in the transfer of the iodine liberated to a receiver charged with a solution of potassium iodide. The iodine collected was titrated with $n/10$ sodium thiosulphate.

Table I. gives results obtained by this method. The

details of the experiments in which steam was used as an agent to force the iodine over are given in Section A, while those of the experiments in which hydrogen was employed are indicated in Section B.

TABLE I.

| Approx. n/10 aluminium chloride solution. | $HIO_3$. | KI. | Time. | Approx. n/10 $Na_2S_2O_3$. | $Al_2O_3$. calculated. | Diff. |
|---|---|---|---|---|---|---|
| C.c. | Grm. | Grm. | Mins. | C.c. | Grm. | Grm. |
| | | | A. | | | |
| 25 | 0·3 | 1·0 | 25 | 25·05 | 0·0427 | −0·0007 |
| 25 | 0·3 | 1·0 | 90 | 25·15 | 0·0428 | −0·0006 |
| | | | B. | | | |
| 25 | 0·3 | 1·0 | 20 | 25·05 | 0·0427 | −0·0007 |
| 25 | 0·3 | 1·0 | 15 | 25·10 | 0·0428 | −0·0006 |
| 25 | 0·3 | 1·0 | 15 | 25·00(*a*) | 0·0426 | −0·0009 |
| 25 | 0·3 | 1·0 | 15 | 25·00(*a*) | 0·0426 | −0·0009 |

(*a*) New standard.

In each of these experiments the iodide-iodate mixture was made by exactly neutralising iodic acid with potassium hydroxide, adding a minute crystal of the iodic acid, introducing the potassium iodide in solution, and taking up with a drop or two of sodium thiosulphate the iodine set free. This mixture was put into the Voit flask together with the aluminium chloride, and the whole was heated in the current of steam or hydrogen.

Applying the process to a solution of potassium alum the results recorded in the following table were obtained :—

TABLE II.

| Approx. n/10 aluminium potassium alum. | $KIO_3$ | KI. | Time. | Approx. n/10 $Na_2S_2O_3$. | $Al_2O_3$ calculated. | $Al_2O_3$ found. | Diff. |
|---|---|---|---|---|---|---|---|
| C c. | Grm. | Grm. | Mins. | C.c. | Grm. | Grm. | Grm. |
| 25 | 0·3 | 1·0 | 30 | 24·55 | 0·0410 | 0·0414 | −0·0004 |
| 25 | 0·3 | 1·0 | 30 | 24·60 | 0·0411 | 0·0416 | −0·0005 |
| 25 | 0·3 | 1·0 | 25 | 24·50 | 0·0409 | 0·0414 | −0·0005 |
| 25 | 0·3 | 1·0 | 30 | 24·70 | 0·0413 | 0·0416 | −0·0003 |
| 25 | 0·3 | 1·0 | 35 | 24·50 | 0·0409 | 0·0415 | −0·0006 |
| 25 | 0·3 | 1·0 | 30 | 24·55 | 0·0410 | 0·0415 | −0·0005 |
| 25 | 0·3 | 1·0 | 25 | 24·50 | 0·0409 | 0·0415 | −0·0006 |

In Table III. are shown results of the application of the process to an ammonium alum.

TABLE III.

| Approx. n/10 ammonium alum. | $KIO_3$. | KI. | Time. | Approx. n/10 $Na_2S_2O_3$. | $Al_2O_3$ calculated. | Diff. |
|---|---|---|---|---|---|---|
| C.c. | Grm. | Grms. | Mins. | C.c. | Grm. | Grm. |
| 25 | 0·3 | 1·0 | 20 | 25·20 | 0·0429 | +0·0007 |
| 25 | 0·3 | 1·0 | 15 | 25·17 | 0·0429 | +0·0007 |
| 25 | 0·3 | 1·0 | 20 | 25·10(*b*) | 0·0427 | +0·0005 |
| 25 | 0·3 | 1·0 | 25 | 25·20(*b*) | 0·0429 | +0·0007 |
| 25(*a*) | 0·3 | 1·0 | 12 | 25·70(*b*) | 0·0421 | −0·0001 |
| 25(*a*) | 0·3 | 1·0 | 12 | 24·65(*b*) | 0·0420 | −0·0002 |
| 25 | 0·3 | 1·0 | 20 | 25·20(*c*) | 0·0430 | +0·0008 |
| 25 | 0·3 | 1·0 | 25 | 25·15(*c*) | 0·0429 | +0·0007 |
| 25 | 0·3 | 2·0 | 25 | 25·20(*c*) | 0·0430 | +0·0008 |
| 25 | 0·3 | 2·0 | 20 | 25·15(*c*) | 0·0429 | +0·0007 |

(*a*) Liquid in Voit flask not clear.
(*b*) New standard.
(*c*) New standard.

These results proved to be too high, and led to the conclusion that the ammonium sulphate was acted upon by the iodic mixture, liberating an additional portion of iodine. Experiments with ammonium sulphate verified the supposition, and the process is therefore less accurate in the presence of ammonium salts. In fact, ammonium sulphate in the amounts taken may be completely hydrolysed in the course of three hours, about one-half of the iodine liberated by the sulphuric acid formed in the hydrolysis being available for estimation under the conditions of the foregoing determinations. When, however, the distillate is collected in a solution of potassium iodide containing sufficient acid to combine with the ammonia volatilised, iodine is liberated in amount equivalent to the entire quantity of sulphates present, and may be titrated with sodium thiosulphate.

The reaction between iodine and ammonia in alkaline solution, and the hydrolysis of ammonium salts, are undergoing further investigation by the writer.

The attempts to obtain a complete reaction by heating the mixture in a pressure bottle showed that the results of this procedure are low, although but slightly deficient, and cannot be used for estimating correctly the amount of aluminium salt in the solution.

The following method can be recommended as one giving constant results which correspond closely with the gravimetric determinations and the theoretical amount of alumina in neutral aluminium chloride, sulphate, or alum, little time being necessary for a single determination :—

Measure 25 c.c. of the approximately n/10 solution of the neutral aluminium salt to be analysed into a Voit flask, and to this add a mixture of 10 c.c. of a solution of neutral potassium iodate (30 grms. to a litre), and 1·0 grm. potassium iodide. Pass a current of hydrogen through the liquid, and heat for fifteen to twenty-five minutes, or until the solution is nearly colourless, collecting the iodine liberated in a Drexel flask, about half full of water, in which 3 grms. of potassium iodide is dissolved. Titrate with sodium thiosulphate the iodine in the Drexel flask and that which remains in the solution in the Voit flask, and calculate the amount of alumina, $Al_2O_3$, corresponding to the iodine, 6I, liberated.

The writer wishes to thank Prof. F. A. Gooch for friendly assistance during this investigation.—*American Journal of Science*, xx., p. 181.

## A REVISION OF THE ATOMIC WEIGHT OF CADMIUM.*

By GREGORY PAUL BAXTER, MURRAY ARNOLD HINES, and HARRY LOUIS FREVERT.

(Concluded from p. 237).

*Method of Analysis* (continued).

The average of these results is almost identical both with that obtained in the previous analysis of cadmium chloride, 112·469, and with that obtained from the bromide, 112·467; hence it is evident that no serious error was introduced in our earlier work by the use of phosphorus pentoxide for drying hydrochloric acid gas. Furthermore, in other analyses of chlorides in this laboratory, where the salts were fused in an atmosphere containing hydrochloric acid, either the salt employed was initially anhydrous, so that it could not have taken up the phosphorus, as in the case of magnesium ammonium chloride (Richards and Parker, *Proc. Amer. Acad.*, 1896, xxxii., 55), and of strontium chloride (Richards, *Ibid.*, 1905, xl., 603), or else the concentrations of hydrochloric acid gas were so low that no error could have been introduced through the use of the hydrochloric acid, as in the case of calcium chloride (Richards, *Journ. Am. Chem. Soc.*, 1902, xxiv., 374).

Although Bailey and Fowler attribute to hydrobromic acid an effect similar to that of hydrochloric acid, for several reasons it is certain that in the experiments upon cadmium bromide described in the earlier part of this paper no appreciable amount of phosphorus was introduced into the salt by the action of the hydrobromic acid upon the

* From the *Journal of the American Chemical Society*, xxviii., No. 6.

THE ATOMIC WEIGHT OF CADMIUM.

Ag = 107·930. Cl = 35·473 (*a*).

| No. of analysis. | Weight of $CdCl_2$ in vacuum (grms.). | Weight of residue (grm.). | Loss in weight of boat (grm.). | Weight of Ag in vacuum (grms.). | Weight of AgCl in vacuum (grms.). | Weight of Ag added or subtracted (grm.). | Loss on fusion (grm.). | Weight of asbestos from filtrate (grm.). | Weight of AgCl from washwaters (grm.). | Corrected wt. of $CdCl_2$ (grms.). | Corrected weight of Ag (grms.). | Corrected wt. of AgCl (grms.). | Atomic weight of cadmium. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $CdCl_2$ : 2Ag. | | | | | | | |
| 17. | 5·62511 | 0·00015 | 0·00004 | 6·61993 | — | 0·00000 | — | — | — | 5·62500 | 6·61193 | — | 112·472 |
| 18. | 6·81040 | 0·00026 | 0·00017 | 8·01516 | — | 0·00020 | — | — | — | 6·81031 | 8·01496 | — | 112·470 |
| 19. | 5·50097 | 0·00017 | 0·00009 | 6·47393 | — | 0·00000 | — | — | — | 5·50089 | 6·47393 | — | 112·470 |
| | | | | | | | | | | Average .. | .. | .. | 112·471 |
| | | | | | | $CdCl_2$ : 2AgCl. | | | | | | | |
| 20. | 6·11757 | 0·00004 | +0·00003 | — | 9·56432 | — | 0·00013 | 0·00024 | 0·00147 | 6·11750 | — | 9·56590 | 112·470 |
| 21. | 6·81040 | 0·00026 | 0·00017 | — | 10·64731 | — | 0·00010 | 0·00061 | 0·00136 | 6·81031 | — | 10·64918 | 112·471 |
| 22. | 5·50097 | 0·00017 | 0·00009 | — | 8·59940 | — | 0·00008 | 0·00052 | 0·00190 | 5·50089 | — | 8·60174 | 112·469 |
| | | | | | | | | | | Average .. | .. | .. | 112·470 |

(*a*) Richards and Wells, Publications of the Carnegie Institution of Washington, No. 28, 1905; *Journ. Am. Chem. Soc.*, xxvii., 459.

phosphorus pentoxide. In the first place, the experiment of passing into water hydrobromic acid gas, formed as in our work by passing nitrogen through bromine and then through an emulsion of red phosphorus in concentrated hydrobromic acid solution, and dried first by fused calcium bromide and then by phosphorus pentoxide, was performed in this laboratory some years ago in connection with the analysis of cobalt and nickel bromides (Richards and Baxter, *Proc. Amer. Acad.*, 1899, xxxiv., 361). In this experiment no phosphorus could be discovered in the aqueous solution. In the second place, in two analyses of bromides which had been heated in hydrobromic acid gas, the filtrates from the silver bromide precipitates were evaporated to small bulk and tested for phosphoric acid, with negative results, while the slight residues obtained by filtering the aqueous solutions of the original bromides also showed in one case the complete absence of phosphorus, and in the other the presence of only a minute trace of this substance, although in the latter case the salt has been sublimed in a current of hydrobromic acid, and therefore contained maximum amounts of phosphorus (Baxter, *Proc. Amer. Acad.*, 1903, xxxix., 248). This result was to be expected from a consideration of the fact that the hydrobromic acid gas used in these experiments was diluted with at least twice its volume of nitrogen. In the light of this evidence it seems safe to assume that in the numerous analyses of bromides which have been carried out in this laboratory in recent years, no error was introduced by the use of phosphorus pentoxide as a drying agent for the hydrobromic acid gas. Nevertheless, with more concentrated hydrobromic acid, doubtless it would be unwise to use this drying agent.

It is interesting to compare the results of the analyses of the different fractions of material.

| Fraction. | | | Average. |
|---|---|---|---|
| I. .. .. | $CdCl_2$ : 2Ag | 112·468 | 112·470 |
| I. .. .. | $CdCl_2$ : 2AgCl | 112·471 | |
| II., Series 1 | $CdCl_2$ : 2Ag | 112·456 | 112.469 |
| II., Series 1 | $CdCl_2$ : 2AgCl | 112·481 | |
| II., Series 2 | $CdCl_2$ : 2Ag | 112·471 | 112·471 |
| II., Series 2 | $CdCl_2$ : 2AgCl | 112·470 | |
| II. .. .. | $CdBr_2$ : 2Ag | 112·467 | 112·466 |
| II. .. .. | $CdBr_2$ : 2AgBr | 112·465 | |
| III. .. .. | $CdBr_2$ : 2Ag | 112.472 | 112·468 |
| III. .. .. | $CdBr_2$ : 2AgBr | 112·464 | |
| | Average .. | 112·469 | 112·469 |

The close agreement of the results from fraction II. by different methods and of the results from all three fractions leaves no doubt of the identity of the different specimens of material.

No matter how the results are averaged, the same conclusion is reached as in the preliminary paper, *i.e.*, that the atomic weight of cadmium lies very near the value 112·47 (Ag = 107·930).

It is interesting to compare the results of our work with those obtained by other experimenters. From the following list of investigations upon the atomic weight of cadmium it can be seen that this subject has attracted considerable attention, especially in recent years. The following atomic weights are assumed:—O = 16·00; C = 12·00; S = 32·06; Cl = 35·47; Br = 79·96; Ag = 107·93; I = 126·98:—

The greater portion of this list is to be found in Clarke's "Recalculation of the Atomic Weights," Smithsonian Mis. Coll., 1897.

Stromeyer (*Schweigger's Journ.*, 1818, xxii., 366).

| | |
|---|---|
| Cd : CdO .. .. .. .. | 111·5 |
| Cd : CdS .. .. .. .. | 113·8 |
| Cd : $Cl_2$ .. .. .. .. | 112·8 |
| Cd : $I_2$ .. .. .. .. | 111·7 |

von Hauer (*Journ. Prakt. Chem.*, 1857, lxxii., 350).

| | |
|---|---|
| $CdSO_4$ : CdS .. .. .. | 111·94 |

Lenssen (*Journ. Prakt. Chem.*, 1860, lxxix., 281).

| | |
|---|---|
| $CdC_2O_4$ : CdO .. .. .. | 112·0 |

Dumas (*Ann. Chem. Pharm.*, 1860, cxiii., 27).

| | |
|---|---|
| $CdCl_2$ : 2Ag .. .. .. | 112·43 |
| | 111·95 |

Huntington (*Proc. Amer. Acad.*, 1881, xvii., 28).

| | |
|---|---|
| $CdBr_2$ : 2Ag .. .. .. | 112·24 |
| $CdBr_2$ : 2AgBr .. .. .. | 112·23 |

Partridge (*Amer. Journ. Sci.*, [3], 1890, xl., 377).

| | |
|---|---|
| $CdC_2O_4$ : CdO .. .. .. | 111·80 |
| $CdSO_4$ : CdS .. .. .. | 111·73 |
| $CdC_2O_4$ : CdS .. .. .. | 111·67 |

Morse and Jones (*Amer. Chem. Journ.*, 1891, xiv., 261).

| | |
|---|---|
| Cd : CdO .. .. .. | 112·07 |
| $CdC_2O_4$ : CdO .. .. .. | 112·02 |

Lorimer and Smith (*Zeit. Anorg. Chem.*, 1892, i., 364).

| | |
|---|---|
| CdO : Cd .. .. .. .. | 112·04 |

Bücher "Doctoral Dissertation," Baltimore, Md., 1895.

| | |
|---|---|
| $CdC_2O_4$ : CdO .. .. .. | 111·88 |
| $CdC_2O_4$ : CdS .. .. .. | 112·15 |
| $CdCl_2$ : 2AgCl .. .. | 112·37 |
| $CdBr_2$ : 2AgBr .. .. | 112·39 |
| Cd : $CdSO_4$ .. .. | 112·35 |
| Cd : CdO (porcelain) | 112·08 |
| Cd : CdO (platinum) | 111·89 |

Hardin (*Journ. Amer. Chem. Soc.*, 1896, xviii., 1016).

| | |
|---|---|
| $CdCl_2$ : Cd .. .. .. | 112·12 |
| $CdBr_2$ : Cd .. .. .. | 112·06 |
| Cd : Ag .. .. .. | 111·99 |

Morse and Arbuckle (*Amer. Chem. Journ.*, 1898. xx., 536).

| | |
|---|---|
| Cd : CdO .. .. .. .. | 112·38 |

Baxter and Hines (*Journ. Amer. Chem. Soc.*, 1905, xxvii., 222).

| | |
|---|---|
| $CdCl_2$ : 2Ag .. .. .. | 112·462 |
| $CdCl_2$ : 2AgCl .. .. .. | 112·476 |

The relative value of many of these determinations has already been several times discussed, and since it is invariably a difficult matter intelligently to criticise experimental work without an actual repetition of the experiments, for frequently some constant source of error is so securely hidden that it may be detected only by the most careful investigation, no attempt at criticism is made here. (Clarke, Partridge, Morse and Jones, *loc. cit.*; Richards, *Amer. Chem. Journ.*, , 1898, xx., 547.)

Furthermore, the uncertainty which now exists as to the relation between several fundamental atomic weights, *e.g.*, silver and oxygen, makes it a matter of considerable doubt whether, when this uncertainty is removed, some of the discrepancies in the foregoing table will not disappear. (Richards, Publications of the Carnegie Institution, No. 28, p. 67; "Report of the International Committee on Atomic Weights," *Journ. Am. Chem. Soc.*, 1906, xxviii., 1).

Attention should be called to the agreement with ours of the results of Bucher's painstaking work upon the halogen compounds of cadmium. The values from cadmium chloride vary between 112·26 and 112·46, with an average of 112·37, but if the first seven of his twenty-one experiments are rejected, his average becomes 112·40, and six of his results are as high as 112·43. His analyses of the bromide vary between 112·30 and 112·46, with an average of 112·39.

The results of this investigation are then as follows:—

1. The value for the atomic weight of cadmium previously found by analysis of cadmium chloride, 112·47 (Ag = 107·930), is supported by the analysis of cadmium bromide and by new analyses of cadmium chloride.

2. Phosphorus pentoxide is found to be attacked by pure hydrochloric acid gas, and hence is unsuited for drying this gas, thus confirming the results of Bailey and Fowler.

3. It is shown that no appreciable error is introduced from this source, if a *dry* salt is fused in a current of hydrochloric acid which has been dried by phosphorus pentoxide.

4. It is pointed out that in the case of hydrobromic acid diluted with twice its volume of nitrogen no similar effect is produced.

We are deeply indebted to the Carnegie Institution of Washington, with whose generous aid this investigation has been completed, and also to the Cyrus M. Warren Fund for Research in Harvard University for indispensable platinum vessels.

# PROCEEDINGS OF SOCIETIES.

## CHEMICAL SOCIETY.

*Ordinary Meeting, November 1st, 1906.*

Prof. R. Meldola, F.R.S., President, in the Chair.

(Concluded from p. 240).

192. "*Some Derivatives of Catechol, Pyrogallol, Benzophenone, and of Substances Allied to the Natural Colouring Matters.*" By William Henry Perkin, jun., and Carl Weizmann.

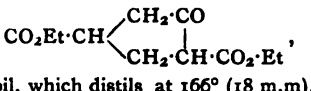
This communication contains the description of the preparation and properties of a number of new substances obtained at different times in connection with researches on the constitution of brazilin, hæmatoxylin, and other natural colouring matters.

193. "*Experiments on the Synthesis of the Terpenes.* Part IX. *The Preparation of* Cyclo*pentanone-3-carboxylic Acid and of* Cyclo*hexanone-4-carboxylic Acid (δ-Ketohexahydrobenzoic Acid).*" By Francis William Kay and William Henry Perkin, jun.

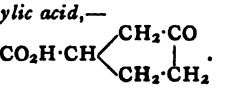
When ethyl butane-αβδ-tricarboxylate,—

$$CO_2Et{\cdot}CH_2{\cdot}CH(CO_2Et){\cdot}CH_2{\cdot}CH_2{\cdot}CO_2Et,$$

is heated with sodium, and the product acidified, it yields *ethyl* cyclo*pentanone-2 : 4-dicarboxylate*,—



a colourless oil, which distils at 166° (18 m.m), and, when digested with dilute sulphuric acid, is readily hydrolysed with elimination of carbon dioxide and formation of cyclo*pentanone-3-carboxylic acid*,—

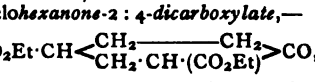


This new acid melts at 65°, and yields an *oxime* (m. p. 141°) and a *semicarbazone* (m. p. 195°).

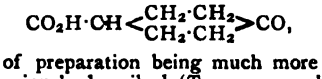
When ethyl pentane-αγε-tricarboxylate,—

$$CO_2Et{\cdot}CH_2{\cdot}CH_2{\cdot}CH(CO_2Et){\cdot}CH_2{\cdot}CH_2{\cdot}CO_2Et,$$

is treated with sodium, it is converted in a similar manner into *ethyl* cyclo*hexanone-2 : 4-dicarboxylate*,—



which distils at 180° (20 m.m.), and, on hydrolysing with dilute sulphuric acid, yields δ-ketohexahydrobenzoic acid,—



this method of preparation being much more convenient than that previously described (*Trans.*, 1904, lxxxv., 418). The authors wish to reserve the further investigation of the substances described in this preliminary communication.

194. "*The Hydrolysis of 'Nitrocellulose' and 'Nitroglycerin.'*" By Oswald Silberrad and Robert Crosbie Farmer.

The authors have studied the hydrolysis of nitrocellulose, nitroglycerin, and mixtures of the two in the form of cordite and ballistite. The hydrolysis is complicated by the simultaneous reduction of the nitric acid, as shown by (1) the formation of large quantities of nitrites, (2) the degradation of the cellulose and glycerol to hydroxy-acids, &c., (3) the abnormally high saponification equivalents found (9·2 to 9·5 for pentanitrocellulose and 4·85 for nitroglycerin), (4) the abnormality of the velocity curves. Intermediate products are formed which are gradually acted on by the alkali; these are practically insoluble in water, and do not give rise to free acid when left in contact with water for several days.

With the aid of velocity determinations with varying quantities of gun-cotton, a formula was deduced whereby

the velocity was calculated with which the reaction would occur if perfect diffusion took place. The following results were obtained when gun-cotton was suspended in 400 c.c. of acid or alkali at 37·8°.

| Grms. of gun-cotton. | Concentration of H or OH ions. | Velocity (grm.-equiv. of acid liberated per hour). Calculated. | Found. |
|---|---|---|---|
| | *1. Hydrolysis by Baryta Solution.* | | |
| 3·10 | 0·197 | 0·0035 | 0·0033 |
| 4·97 | 0·191 | 0·0051 | 0·0053 |
| 20·42 | 0·096 | 0·0070 | 0·0071 |
| 22·10 | 0·189 | 0·0144 | 0·0142 |
| ∞ | 1·000 | 0·168 | — |
| | *2. Hydrolysis by Nitric Acid.* | | |
| 5·10 | 0·821 | 0·00018 | 0·00018 |
| 10·00 | 0·821 | 0·00022 | 0·00021 |
| 20·35 | 0·821 | 0·00025 | 0·00024 |
| ∞ | 1·000 | 0·000347 | — |

From the limiting velocities thus determined, it was calculated that the hydrolysis of nitrocellulose will take place with the minimum velocity when the concentration of the hydrogen ions is $3·7 \times 10^{-6}$ and that of the hydroxyl ions $7·8 \times 10^{-9}$ grm.-equivalent per litre. Under these conditions, the hydrolysis will proceed with such a velocity as as to liberate $5·6 \times 10^{-8}$ grm.-equivalents of acid per litre of water per year.

195. "*The Acidic Constants of some Ureides and Uric Acid Derivatives.*" By JOHN KERFOOT WOOD.

The investigation was undertaken with the object of determining the influence of other groups on the acidity of the imino-group. In compounds which contain the grouping ·CO·NH·CO·NH·CO·, there appears to be a mutual reinforcement of the imino-groups, analogous to the reinforcement of the carboxyl groups in succinic acid. Divergent results were obtained with barbituric and C-ethylbarbituric acids, the dissociation constants of which are many times greater than those of the other substances investigated; this high acidity is due to the $CH_2$ or $CH(C_2H_5)$ group.

196. "*The Affinity Constants of Xanthine and its Methyl Derivatives.*" By JOHN KERFOOT WOOD.

The author described the results of determinations of the basic and acidic constants of xanthine, 7-methylxanthine, the three isomeric dimethylxanthines, and caffeine. There is no great variation in the values of the basic constants, but a very striking difference in the values of the acidic constants is to be noticed. The dimethylxanthines, especially paraxanthine and theophylline, are stronger acids than any of the other members of the series. Moreover, when the results for the three dimethylxanthines are compared amongst themselves, it is seen that they are not in agreement with the constitutions of the isomerides. The conclusion is drawn that these results are to be explained by a stereochemical influence exerted by the two methyl groups, the influence varying in magnitude according to the positions in the xanthine nucleus which the methyl groups occupy.

197. "*The Explosive Combustion of Hydrocarbons.*" (II.). By WILLIAM ARTHUR BONE, JULIAN DRUGMAN, and GEORGE WILLIAM ANDREW.

The authors have further examined the phenomena associated with the "inflammation" of mixtures of ethane or ethylene and oxygen corresponding to $C_2H_6 + O_2$ and $3C_2H_4 + 2O_2$ respectively, by a method which allows of discrimination between the various products according as they arise at an earlier or later stage in the flame. In each case, steam, aldehydes, ethylene, and acetylene are prominent during the initial stages of combustion, whilst carbon is a later product. Steam is so rapidly decomposed by carbon at high temperatures that prolonged duration of the flame diminishes the quantity of water which separates on cooling.

The authors have also succeeded in producing "detonation" in mixtures of ethane, or butane, and oxygen corresponding to $C_2H_6 + O_2$ and $C_4H_{10} + 2O_2$ respectively, at initial pressures of 900 m.m. and upwards. The mechanism of combustion under these conditions does not, however, appear to be essentially different from what it is in ordinary flames.

198. "*Contributions to the Theory of Solutions. I. The Nature of the Molecular Arrangement in Aqueous Mixtures of the Lower Alcohols and Acids of the Paraffin Series. II. Molecular Complexity in the Liquid State. III. Theory of the Intermiscibility of Liquids.*" By JOHN HOLMES.

The author has determined the relative densities of mixtures of carbon disulphide with ethyl- and *n*-propyl-alcohols respectively, and of pyridine with water and ethyl alcohol.

From a consideration of the nature of the volumetric changes occurring in these and other mixtures of liquids, it is concluded that the sphere of activity of a molecule is not an invariable function of the molecular volume, as ascertained from its molecular weight and specific gravity.

On these changes the author bases a theory of intermiscibility, depending on differences in the degree of repulsion between liquid molecules.

199. "*The Relation between Natural and Synthetical Glycerylphosphoric Acids.*" (Part II.). By FRANK TUTIN and ARCHIE CECIL OSBORN HANN.

With the object of ascertaining the nature of the natural and synthetical glycerylphosphoric acids, the authors have synthesised the unsymmetrical or α-acid, $OH·CH_2·CH(OH)·CH_2·O·PO_3H_2$, and the symmetrical or β-acid, $(CH_2·OH)_2:CH·O·PO_3H_2$, and have compared the barium and brucine salts with the corresponding salts of the natural and synthetical acids.

*α-Glycerylphosphoric acid* was prepared by the action of phosphoric acid on β-dichlorohydrin and subsequent hydrolysis of the product.

*β-Glycerylphosphoric acid* was prepared by the hydrolysis of *β-diglycerylphosphoric acid* (m. p. of calcium salt 249—250°), which had been obtained by the action of phosphoryl chloride on α-dichlorohydrin and subsequent hydrolysis of the product.

The racemised natural acid was prepared by the hydrolysis of egg lecithin with hot baryta solution.

The synthetical acid was obtained from glycerol and phosphoric acid under such conditions as had been previously shown to give only the mono-ester.

The barium salts of these acids differ considerably in appearance, solubility, and in the amount of water they contain. The brucine salts differ in the amount of their water of crystallisation, but all melt at 157—159°, and not at 181°, as stated by Carré (*Comptes Rendus*, 1903, cxxxvii., 1070).

It is concluded from the results of this investigation that the natural and synthetical glycerylphosphoric acids are differently constituted mixtures of the α- and β-acids.

200. "*Thiocarbonic Acid and some of its Salts.*" By IDA GUENEVERE O'DONOGHUE and ZELDA KAHAN.

Thiocarbonic acid has been prepared by the cautious addition of calcium thiocarbonate to cold concentrated hydrochloric acid. It is a heavy, red oil, boiling with decomposition at 50°, and on distillation under diminished pressure decomposes into carbon disulphide, hydrogen sulphide, and sulphur. Thiocarbonic acid expels carbon dioxide from carbonates, and on treatment with metallic sodium or potassium yields the corresponding salts. The normal metallic thiocarbonates are formed by the action of the salts of weak acids on thiocarbonic acid, and are constituted similarly to the corresponding carbonates. The acid has therefore the formula $H_2CS_3$. The salts are very unstable both in air and in a vacuum, some decompose quantitatively into carbon disulphide and metallic sulphide, whilst others give, under similar conditions, a variety of basic compounds.

201. "*Studies in Optical Superposition.*" (Part II.). By Thomas Stewart Patterson and John Kaye.

Di-*l*-menthyl-*l*-tartrate, di-*l*-menthyl diacetyl-*l*-tartrate, and sodium *l*-menthyl *l*-tartrate have been prepared and examined in regard to their optical activity, both in the homogeneous condition, so far as possible, and also in solution. The results are discussed in connection with the problem of optical superposition.

202. "*Optically Active Dihydrophthalic Acid.*" By Allen Neville.

When the hydrogen strychnine salt of trans-$\Delta 3:5$-dihydrophthalic acid is fractionally crystallised from alcohol, the acid is resolved into its lævo- and dextro-isomerides. These melt at 122° and do not lose weight at 100°. They are readily soluble in alcohol, fairly so in ether or chloroform, and insoluble in water. They have $[\alpha]_D$ about 126° in alcohol and about 140° in chloroform.

Heated with water or alkali, they pass to the optically inactive $\Delta 2:6$-modification, and, warmed with acetic anhydride, are transformed to the *cis*-$\Delta 3:5$-modification of dihydrophthalic acid.

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Errata.—P. 230, col. 2, line 21, for "disulphide" read "ethyl sodium thiosulphate." Line 22, for "the mercaptan" read "some mercaptan." Line 24, for "cm." read "dcm."

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## PHYSICAL SOCIETY.

*Ordinary Meeting, November 9th, 1906.*

Prof J. Perry, F.R.S., President, in the Chair.

Mr. G. F. C. Searle gave an Exhibition and Description of Apparatus for Students' Practical Work in Physics.

1. *Diagram of Forces.*—The student finds the magnitude and line of action of the resultant of a number of co-planar forces, represented by lines on a diagram: (*a*) by the parallelogram law; (*b*) by the methods of analytical statics.

2. *The Ballistic Balance.*—Two spheres are suspended by bifilar suspensions. The smaller sphere is released from an electromagnet. The highest points reached by the spheres after impact are observed. The student determines the ratio of the masses and the coefficient of restitution.

3. *Harmonic Motion of a Rigid Body.*—An inertia bar is suspended by a torsion-wire. The couple for a radian is deduced from observations of angles due to known couples. Couples are produced by threads round a cylinder attached to the wire, the threads passing over ball-bearing pulleys and carrying masses. The angles are observed by a simple goniometer. The calculated and observed times are compared.

4. *Determination of the Radius of Curvature of a Concave Mirror by the Oscillation of a Sphere.*—If T be the time of oscillation of the sphere, R the radius of the mirror, and $r$ the radius of the sphere $T = 2\pi\sqrt{7(R-r)/5g}$.

5. *Comparison of Moments of Inertia.*—Two inertia bars A and B are joined by a wire. If $T_1$ be the time of vibration when B is fixed and A performs torsional vibrations, and $T_2$ be the time when A is fixed and B vibrates, then $K_1T_2^2 = K_2T_1^2$ where $K_1$, $K_2$ are the moments of inertia of A and B. If the system is hung up by a silk thread and A and B move in opposite directions, the periodic time $T_3$ is given by $1/T_3^2 = 1/T_1^2 + 1/T_2^2$. A pointer attached to the wire at the "centre of gravity" of the moments of inertia does not vibrate.

6. *System with Two Degrees of Freedom.*—Two inertia bars are connected by a wire and the system is suspended by a wire. There are two normal modes of vibration. In one the bars move in the same direction, in the other they move in opposite directions. The times observed for the two normal vibrations are compared with the times deduced from those observed when each bar vibrates alone.

7. *Determination of the Critical Acceleration of a Pedometer.*—In a pedometer a weight is supported by a spring which is strong enough to sustain it when the instrument is at rest. If the pedometer have an upward acceleration exceeding $f$ the spring cannot sustain the weight, and the motion of the weight starts the mechanism. The pedometer is attached to a spring vibrating vertically. If T be the time of vibration and $a$ the amplitude, the maximum upward acceleration is $4\pi^2a/T^2$. If the mechanism just works $f = 4\pi^2a/T^2$.

8. *Determination of the Roots of Bessel's Function of Zero Order by means of a Vibrating Chain.*—A chain is suspended at one end. By properly timed impulses, applied near the top of the chain, it can be made to vibrate with one, two, three . . . . nodes. If the length of the chain be $l$ and the length of the equivalent pendulum for any mode of vibration be $\lambda$, then $J_0\{2\sqrt{l/\lambda}\} = 0$. The student finds the time of vibration for each mode, and compares it with that given by the theory (Tait, "Dynamics," p. 287).

9. *Apparatus for Testing Hooke's Law.*—Two wires hung side by side carry a jointed frame holding a spirit level. When the load on one wire is increased the level is brought back to its zero reading by a micrometer-screw working in one side of the frame. By taking cycles of loading and unloading, hysteresis effects can be observed in copper wire (*Proc. Camb. Phil. Soc.*, 1900).

10. *Determination of Young's Modulus and Rigidity for a Wire.*—Two inertia bars are connected by the wire. The system is suspended by threads attached to the bars so that the bars and the wire are horizontal. If $T_1$ be the time of vibration of the bars in the horizontal position, $T_1^2 = 8\pi Kl/Ea^4$. One bar is now fixed so that the wire is vertical. If $T_2$ be the time of torsional vibrations of the other bar, $T_2^2 = 8\pi Kl/na^4$. Hence, $E/n = T_2^2/T_1^2$, where E = Young's modulus, $n$ = simple rigidity, K = moment of inertia of bar, $l$ = length of wire, and $a$ = radius of wire (*Phil. Mag.*, Feb., 1900).

11. *Determination of Coefficient of Restitution.*—A steel bicycle ball is allowed to fall from an electromagnet on to a steel anvil. If the ball falls through $h$ and rises through $h'$, the coefficient of restitution ($e$) is given by $e = \sqrt{h'/h}$. The student also finds the loss of energy and the *change* of momentum which occur on impact.

12. *Apparatus for Experiments on Common String.*—When a mass, M, is suspended by a piece of common *twisted* (not plaited) string, the string exerts a couple G upon the mass. If the mass be allowed to start from rest and if it make $n$ revolutions in time $t$, $G = 4\pi nK/t^2$, where K is the moment of inertia of the mass. It is found that G is proportional to M.

13. *Resonance Experiments with a Bottle.*—If the air in a bottle resounds to a fork of frequency $n$ when the volume of air is S, then $S = Cv^2/n^2$, where $v$ is the velocity of sound and C is a constant. Resonance is obtained for a series of forks, the volume S being adjusted by water. On plotting S against $1/n^2$ a straight line is obtained. This line cuts the axis of S at a point which indicates the "correction" due to the neck of the bottle.

14. *Resonator with "Thin Plate" Opening.*—A jar is fitted with a flat top pierced by a rectangular opening. The area of the opening is varied by a sliding plate. The volume of the air in the jar is varied by water. If the opening be *circular*, and if $n$ be the frequency and $v$ the velocity of sound,—

$$n = [v \times (\text{area of opening})^{\frac{1}{2}}]/[2^{\frac{1}{2}}\pi^{\frac{1}{2}}(\text{volume of resonator})^{\frac{1}{2}}].$$

This formula is nearly true for openings of any form.

15. *Mechanical Equivalent of Heat.*—Heat is produced by friction between two cones. The outer cone revolves and the inner one is prevented from revolving by a string passing round a wheel attached to the cone and supporting a weight (E. H. Griffiths, "Thermal Measurement of Energy," p. 125).

16. *Determination of Thermal Conductivity of Copper.*—(*Phil. Mag.*, Jan., 1905).

17. *Determination of Thermal Conductivity of India-rubber.*—Steam passes through a rubber tube. Part of the tube is immersed in water in a calorimeter. If M be the water equivalent of the calorimeter and its contents, K the thermal conductivity of rubber, $a$ and $b$ the external and internal radii of the tube, $l$ the length immersed, and $\theta$ the temperature of the calorimeter,—

$$K = \frac{M}{2\pi l(100-\theta)} \cdot \frac{d\theta}{dt} \cdot \log_e\left(\frac{a}{b}\right).$$

18. *Comparison of Refractive Indices.*—A double convex lens is placed in contact with a horizontal mirror; its focal length is $f$. When a little water ($\mu_1$) is placed between the lens and the mirror, the focal length of the system becomes $F_1$. When aniline ($\mu_2$) is substituted the focal length is $F_2$. Then $(\mu_2-1)/(\mu_1-1) = [(F_2-f).F_1]/(F_1-f)F_2]$. The focal length is found by making a pin coincide with its image.

19. *Focal Length of a Compound Lens System.*—Light from a distant object passes through the system. The system is adjusted on a revolving table so that the Nodal Point of emergence lies on the axis of revolution. In this case the image does not move when the table is slightly turned. The focal length is then equal to the distance from the axis of revolution to the ground-glass or pin by which the position of the image is marked.

20. *Focal Lines by Reflection at a Concave Mirror.*—A piece of ground-glass, with horizontal and vertical cross lines, is illuminated by a flame. Pins are placed to mark the positions of the images of the vertical and of the horizontal lines formed by the mirror, whose axis is horizontal. If the distances of the cross lines and of the images of the vertical and horizontal lines from the mirror be $u$, $v_1$, and $v_2$, then $2/r \cos i = 1/u + 1/v_1$, $2 \cos i/r = 1/u + 1/v_2$, where $r$ is the radius of the mirror and $i$ is the angle of incidence.

21. *Experiments with an Astigmatic Lens.*—Light from a pin-hole passes through the lens and falls on a ground-glass screen. One face of the lens is spherical, the other cylindrical, and the lens is fitted into a plate with a circular opening. When $u$ is the distance of the pin-hole from the lens, focal lines are formed at distances $v_1$ and $v_2$, and the circle of least confusion at $w$ from the lens. Then $1/u + 1/v_1 = 1/f_1$, $1/u + 1/v_2 = 1/f_2$, and $1/u + 1/w = \frac{1}{2}(1/f_1 + 1/f_2)$, where $f_1, f_2$ are the focal lengths in the principal planes of the lens.

22. *Curvature of the Field of a Lens.*—Light from a white back-ground marked by black cross lines passes obliquely through a lens. By aid of a pair of cross wires the images of the vertical and horizontal cross lines are found. These images lie on two curved surfaces. When the obliquity is small the surfaces are ellipsoids of revolution having the centre of the lens for one focus.

23. *Experiment on Spherical Aberration.*—Sodium light passes through a pin-hole and falls on a *large* lens. After passing the lens it falls on a ground-glass screen on which a scale is marked. By this scale the diameter of the luminous patch on the screen is measured for a series of positions of the screen. The position of the geometrical focus is found by "stopping down" the lens by a diaphragm with a small aperture. A clear glass scale lightly coated with paraffin-wax forms a good screen.

24. *Coulomb's Sine Experiment.*—To show that the couple on a magnet in a uniform magnetic field is proportional to the sine of the angle between the axis of the magnet and the direction of the field. The couple is measured by the torsion of a wire.

25. *Coulomb's Vibration Experiment.*—The vibration magneto-meter employed has a long periodic time and small damping. It is practically a plumb-bob carrying a small magnet. The student compares the magnetic force at various distances from the pole of a Robison ball-ended magnet with the earth's magnetic force, and deduces the pole-strength of the Robison magnet. Ball-ended magnets have practically "true poles" (*Proc. Camb. Phil. Soc.*, 1902).

26. *Ball-ended Magnetometer.*—A Robison ball-ended magnet A B is supported on a pivot close to a drawing board. A second Robison magnet C D rests on the board, and deflects A B. If $m$ be the pole-strength of C D the resultant moment of the four forces $m/AC^2$, $m/AD^2$, $m/BC^2$, and $m/BD^2$ about the pivot is equal to $Hl \sin\theta$, where H = Earth's force, $l$ = length of pivotted magnet, and $\theta$ = deflection. Hence $m$ is found.

27. *Comparison of* 10 *Ohms with* 1 *Ohm.*—A coil X of nearly 10 ohms is to be compared with a standard coil U of 1 ohm. By thick copper connectors three coils, each nearly equal to 3U, can be arranged in parallel, when the resistance is P, or in series, when the resistance is S. Then to the second order S = 9P. P is first compared with U. Then U is put in series with S and X is compared with the whole (Glazebrook, *Phil. Mag.*, 1900).

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## FARADAY SOCIETY.

*Ordinary Meeting, November 13th, 1906.*

Dr. F. MOLLWO PERKIN, Treasurer, in the Chair.

MR. W. POLLARD DIGBY read a paper entitled "*Some Investigations relative to the Depreciation of Electrolytically Produced Solutions of Sodium Hypochlorite.*"

This deals in the first place with depreciation taking place in bottles of various colours in which dark amber bottles gave the best results, the loss in 1817 days being about 40 per cent for a solution containing 4·216 grms. of available chlorine per litre. The corrosive action of hypochlorite solutions upon various metals is then discussed, and the depreciations due to graphite, copper, zinc, lead, and iron plates immersed in such solutions are set forth for a period of 480 hours. A much greater depreciation takes place, due to galvanic action, when two dissimilar metals immersed in the liquid are connected by an insulated wire; the paper gives records in the case of twenty-one different couples. When iron is present as one metal in such a couple, the depreciations are generally greater than for any two other metals.

As regards the area of the exposed surface in the cases of single metals immersed in hypochlorite solutions, it was found that doubling or trebling the surface doubled or trebled the rate of depreciation.

Brief reference is made to the value of protective coatings as applied to metal-couples, but no conclusive results were obtained.

As it is a matter of difficulty to paint evenly the inside of small plates, and, still more, of pipes, the writer deprecates reliance upon insulating materials for the protection of any vessel in which hypochlorite liquids are stored, or of any metallic piping in contact with hypochlorite liquids. When once the paint breaks down, corrosion of the metal will follow at a rapid rate.

Accounts are also given of the value of bitumen as a protective agent for wood exposed to hypochlorite solutions.

In conclusion the author urges that storage, transport, and methods of conveyance from place to place, or even from one part of a factory to another, are details meriting attention. Certain conditions of storage may clearly be regarded as fatal to stability, particularly those in which the galvanic action of dissimilar metals is likely to arise.

MR. CHAS. V. BIGGS then read his paper describing "*The Hermite Electrolytic Process at Poplar.*"

This paper is a contribution to the data at present available on the subject of the electrolytic productions of hypochlorites. It consists of a description of the plant in use at Poplar for the preparation of a solution containing about 4·5 grms. of available chlorine per litre, for use as a disinfectant in the borough.

The system adopted is to mix a certain quantity of fluid in an elevated tank, and then to allow this fluid to flow through four double troughs or cells, placed one above the other so that the liquid descends continuously by gravity.

Each trough is divided laterally by a partition, and in each of the two divisions five distinct "elements" are suspended. The positive plates are of thin platinum-wire wound upon slate-slabs, and the negative plates are of zinc. There are thus four troughs each containing ten "elements," or forty cells in all. After passing through the successive cells, the liquid discharges into a carboy. Sodium hydroxide is used as a preservative; it flows drop by drop into the carboy as it is filling, and serves to neutralise free hypochlorous acid. As the liquid passes through the troughs it is subjected to the action of a current of 15 ampères at 230 volts, being 5·6 volts per cell.

The tank is charged by placing in it 100 litres of a saturated solution of sodium chloride and 20 litres of a saturated solution of magnesium chloride. To this is added as much water as will bring the whole up to 840 litres. The rate of flow through the apparatus is 3½ pints per minute.

Curves are appended showing (1) the rise in value of the solution as it passes through the cells, amounting to about 1 grm. per litre for 10 cells; (2) efficiency in grms. per B.T.U. for this plant, which is highest at a current of 16 ampères. Above this ampèrage energy is wasted in heat, and below it the flow becomes too high.

A number of tests of samples of the liquid made are given. Liquid made during the warm weather of the exceptional summer of 1906, at a temperature of 104° F., was found to have lost only 0·1 grm. available chlorine per litre in six weeks. Several samples of liquid made before the conditions of the plant (as to mixing, rate of flow, &c.) were very fully determined, showed losses of 0·1 and 0·2 grm. per litre in six months; the higher strengths (4·8 to 5·3 grms. per litre) losing 0·5 grm in six months.

The author concludes that the magnesium hypochlorite, as made at Poplar, is sufficiently stable for practical purposes, and that it could be made in a warm climate without necessarily rapid deterioration. The warm weather specimens quoted had been kept in ordinary dark glass bottles, merely corked.

Mr. J. B. C. Kershaw (communicated) considered that electrolytic hypochlorite was unlikely to replace bleaching-powder at present prices. He criticised the efficiency of the Hermite plant at Poplar.

Dr. R. S. Hutton hoped that further information regarding the electrodes and other important details of the Poplar plant, and also further data regarding cost and efficiency, would be forthcoming. He drew attention to the theoretical work that had been done on the Continent. Replying to Mr. Kershaw's strictures, efficiency depended on concentration. At Poplar high concentrations were used, so the efficiency was relatively low.

Dr. F. W. Alexander gave complete details regarding the cost of running the Poplar plant. The plant has been producing an average of 200 gallons a day of 0·4 grm. solution since January last at a total cost for current and material of under £33. Two labourers sufficed to watch the plant and bottle the solution. The defects of the original Hermite process had been successfully overcome. They had no trouble with non-conducting films on the zinc cathodes. Non-stability was caused by the presence of undecomposed salt in solution.

Dr. S. Rideal was of opinion that the convenience of being able to make hypochlorite on the spot as required for disinfecting purposes rendered it far more suitable than bleaching-powder. The dust nuisance caused by motors rendered the use of a sterilising fluid for street watering a necessity.

Mr. L. A. Smart remarked on the value of such electrochemical processes to borough engineers if they could be arranged to run so as to increase the load factor of the power station.

Mr. W. Defries pointed out that although the price of raw materials would probably not decrease, that of power tended to diminish, so electrolytic hypochlorite would in time compete favourably, even as regards price, with chloride of lime.

The authors' replies were reserved for the *Transactions*.

The paper by Dr. Alex. C. C. Cumming "*On the Electro-chemistry of Lead*" was taken as read, and the discussion postponed until the December meeting.

## NOTICES OF BOOKS.

*Soldering, Brazing, and the Joining of Metals.* By Thomas Bolas, F.C.S., F.I.C. Third Edition. London: Dawbarn and Ward, Ltd. 1906.

Occasions arise in every laboratory when the power to successfully braze or solder metal-work is of great value. Little accidents happen to apparatus while in use that must be instantly set right; opportunity occurs for some device in metal, too trivial to hand over to a professional metal worker, which if it could be carried out at the moment would help one over a difficulty.

This little book gives plain instructions and practical hints on soldering and metal working, from the simple operations of putting a patch on a water-bath or joining a lead pipe to the building up of elaborate designs in art metal-work, and is well worth the modest sixpence at which it is published.

*Elementary Science of Common Life (Chemistry).* By W, T. Boone, B.A., B.Sc. London: University Tutorial Press, Ltd. 1906.

This book has been written to meet the requirements of the Syllabus for Subject XXVI. of the Board of Education Examinations, and candidates cannot do better than to use it, while other students also will find it stimulating and helpful. It gives directions for an instructive course of experimental work, which can be performed with a limited amount of comparatively simple apparatus, beginning with six chapters on physics, more especially heat, and proceeding to the chemistry of air, fuels, water, and various chemical substances, such as the common acids, bases, metals, and salts. The practical usefulness in every-day life of the information imparted is kept well before the students' eyes, so that the interest of the boy of average intelligence is certain to be aroused, and in spite of the fact that he is preparing for an examination he should acquire a certain approximation to the valuable scientific habit of thought which it should be the aim of the teacher to produce at all costs. The book contains the examination papers set by the Board in 1905, besides sets of questions, and the author is to be congratulated on the skill with which he handles his subject.

*J. G. Gentele's Lahrbuch der Farbenfabrikation.* ("J. G. Gentele's Text-book of the Manufacture of Colours"). Third Edition. Edited by Dr. A. Buntrock. Volume I. Braunschweig: Friedrich Vieweg und Sohn. 1906.

The third edition of Gentele's Text-book of the Manufacture of Colours will be welcomed by chemists and others interested in the industry who have found the original, which is now somewhat out of date, useful. In the first volume, which is devoted to the earthy pigments, naturally the chief alterations relate to the improvements of mechanical appliances, and it gives general methods of obtaining and purifying the pigments and preparing them for use. The second part of the book enumerates all the commonly used earthy colouring materials, describes the application of general methods to particular cases, and also discusses the properties and uses of the individual substances, notes on the analysis of the raw materials being included. The book will be of interest to chemists and manufacturers, and also to those who use the pigments and who wish to acquire some knowledge of their composition and properties.

# CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxliii., No. 18, October 29, 1906.

**Dissociation of Matter under the Influence of Light and Heat.**—Gustave Le Bon.—The author describes an experiment which gives a further proof of the universal radio-activity of matter—a fact which he has been trying to demonstrate for some years. All bodies possess to a very slight degree the properties which radium and uranium have in a very high degree. It is not only under the influence of heat that metals tend to lose their faculty of radio-active emission; they lose it also to a slight degree when under the influence of prolonged action of light, even when the luminous source does not sensibly raise their temperature. A metal which gives an almost instantaneous discharge at first, and an electrometer when luminous rays first fall on its surface, loses the residue more and more slowly. Ramsay and Spencer have investigated this "fatigue of metals" under the influence of light. They attribute it to a modification of equilibrium of the atomic elements of its surface by reason of the loss of a certain number of electrons produced by the disintegration of the material.

**Phenylic Migration. Method of Fixation of Hypo-iodous Acid and Elimination of Hydriodic Acid.**—M. Tiffeneau.—During the fixation of the radicle IOH the oxyhydrile shows a preference for the most substituted carbon atom and the one nearest to the phenyl. When the HI is eliminated the oxyhydrile nearest to the phenyl remains unattacked, and migration of the phenyl takes place. On the contrary, when the oxyhydrile is furthest away from the phenyl the elimination of the HI tends to form ethylene oxides.

*Berichte der Deutschen Chemischen Gesellschaft.* Vol. xxxix., No. 13, 1906.

**Oxides of Sulphuretted Hydrogen.**—Emil Fromm and José de Seixas Palma.—Sulphurous acid ($H_2SO_3$) is the mother substance of the sulphonic acids $R.SO_3H$. $H_2SO_2$ (sulphoxylic acid), has not yet been prepared in the pure state, nor its salts, but hydrosulphites, *e.g.*, $Na_2S_2O_4$, and sulphinic acids, $R.SO_2H$, sulphones, $R.SO_2.R$, and compounds of sulphoxylic acid with aldehydes and ketones, are known. $H_2SO$, which may be called sulphur hydrate, is unknown, but substituted organic derivatives of it, *e.g.*, the sulphoxides, R.SO.R, have been prepared. The authors have used benzyl chloride and alkali as reagents for the preparation of these oxides. Just as sulphurous acid is converted by their action until benzyl sulphonic acid, so sulphoxylic acid can be converted into sulphinic acids and sulphones, and sulphur hydrate into sulphoxides, R.SO.R. When the action of these reagents on sodium hydrosulphite was investigated, it was found that a hot alkaline solution of the hydrosulphite behaved like a solution of sulphurous acid and sulphoxylic acid salt. The sulphite gives with benzyl chloride sulphonic acid salt, and the sulphoxylate gives benzyl sulphone. It must be assumed that sodium sulphoxylate with benzyl chloride gives first benzyl sulphinic acid and then the further action of benzyl chloride gives benzyl sulphone. These experiments show that not only is sulphurous acid the mother substance of the sulphonic acids, but also sulphoxylic acid, $H_2SO_2$, is the mother substance of the sulphinic acids and sulphones.

**Ammonium Syngenite.**—J. D'Ans.—If gypsum is introduced into an almost saturated solution of ammonium sulphate and the whole allowed to stand at the ordinary temperature under a bell glass, the double salt is formed in a few days. It consists of glittering needles like potassium syngenite. The author's experiments show that it contains only one molecule of water having the formula $(NH_4)_2Ca(SO_4)_2.H_2O$. It is stable at 25°.

**New Nickel Reaction.**—Hermann Grossmann and Bernhard Schück.—If a solution of dicyandiamide (which can be bought very cheaply) is boiled with a few drops of hydrochloric acid for a minute, then a nickel salt solution added and some caustic potash, a yellow crystalline precipitate is formed. This precipitate, which becomes flesh-coloured on heating, is very difficultly soluble in water and practically insoluble in ammonia. Caustic potash does not decompose it, even on boiling, but potassium cyanide at once dissolves it. Its formula is $Ni(N_4H_5C_2O)_2+2H_2O$. The following table shows the sensitiveness of the test. Solution I. contains 1 grm. of nickel carbonate dissolved in a little hydrochloric acid, solution made up to 100 c.c. with water. Solution II. is a 5 per cent solution of dicyandiamide. In the second series of experiments Solution I. contains 1 grm. of nickel carbonate in 200 c.c. of water. Thus the test is not so delicate as that recommended by Tschugaeff, but the reagent is cheap and easily procurable. The test is not affected by the presence of cobalt, which gives no corresponding cobalt compound.

| I. C.c. | II. C.c. | Total vol. C.c. | Remarks |
|---|---|---|---|
| 10 | 10 | 45 | Immediate yellow coloration and precipitate. |
| 5 | 10 | 25 | |
| 2 | 5 | 20 | Intense coloration. Precipitate on boiling. |
| 1 | 5 | 20 | |
| 5 | 10 | 50 | Immediate yellow coloration and precipitate. |
| 2 | 10 | 40 | Precipitate on boiling. |
| 1 | 8 | 40 | Light coloration. Precipitate after some minutes. |
| 0·5 | 5 | 20 | Precipitate on standing for one hour. |
| 0·2 | 5 | 20 | Very faint yellow coloration. Precipitate after two days. |

**Quantitative Separation of Beryllium from Aluminium.**—B. Glassmann.—The author's method is based upon the fact that when sodium thiosulphate is added to a solution of a beryllium salt and the liquid is boiled, it becomes turbid in consequence of the sulphur separated, but the beryllium remains in solution as sulphite or basic sulphite, while the aluminium is precipitated quantitatively as hydroxide. The solution of the oxides containing hydrochloric or sulphuric acid is first approximately neutralised with sodium carbonate, an excess of sodium thiosulphate is added, and the whole boiled till the smell of sulphurous acid has passed off. The liquid is then heated for half-an-hour on the water-bath. The aluminium oxide mixed with sulphur is washed and ignited. In the filtrate the excess of thiosulphate is decomposed with hydrochloric acid, and the beryllium is precipitated with ammonia (or better with an iodide-iodate mixture as described in the following article).

**Quantitative Determination of Beryllium.**—B. Glassmann.—Iodine is set free from a mixture of solutions of potassium iodide and iodate by beryllium salts, as shown in the following equation:—

$$3BeSO_4+5KI+KIO_3+3H_2O = 3Be(OH)_2+3K_2SO_4+3I_2.$$

The reaction proceeds slowly in the cold, but when the mixture is warmed and the iodine is removed with thiosulphate it is complete in a few minutes, even in dilute solutions. The precipitate of beryllium hydroxide settles quickly, and allows of rapid filtration and washing. The solution in which the beryllium is to be determined must be neutral or very faintly acid; if it contains excess of acids it must be neutralised with caustic soda till a precipitate begins to form, and this must then be dissolved in a few drops of dilute hydrochloric acid. Then an excess of a mixture of equal parts of 25 per cent potassium iodide and saturated potassium iodide solution is added (containing about 7 per cent of iodate). After five minutes the iodine separated is accurately decolorised with 20 per cent

sodium thiosulphate solution, and a little more of the iodide-iodate mixture is added in order to show that no more iodine can be separated. Then a small excess of thiosulphate is introduced, and the mixture heated on a water-bath. The precipitate is filtered off, washed with boiling water, dried, and ignited.

**Analytical Examination of High Percentage Gases.**—Alfred Stock and Carl Nielsen.—The ordinary absorption methods of determining gases are inaccurate because of the solvent power of water on gases, especially air. This inaccuracy becomes very great when pure or very high percentage gases are used. The authors suggest an improved apparatus for their estimation. Thus, to determine accurately a gaseous residue of less than 1 per cent in oxygen they fuse to an ordinary Hempel's burette a measuring pipette of 1 c.c. volume. This is connected with a cock with capillary bore through which the gas is introduced. Instead of bringing back into the Hempel's burette the gaseous residue freed from oxygen in the gas pipette. they read its volume off in the 1 c.c. pipette. For the absorption of the oxygen they use either copper wire gauze in ammonia solution containing carbonate, or alkaline ferrotartrate solution. It is generally assumed that by boiling and cooling rapidly water can be freed from air, but the authors have found that air is again quickly absorbed when the water comes into intimate contact wth air; for example, on filling a long gas-burette the water contains no air only as long as it is kept from contact with air.

**Mixtures of Liquid Oxygen and Nitrogen.**—Alfred Stock and Carl Nielsen.—Erdmann and Bedford have called attention to a physical affinity between liquid oxygen and liquid nitrogen, stating that liquid oxygen cannot be freed from dissolved nitrogen even by continued boiling. The authors have investigated this phenomenon. They prepared pure oxygen and liquefied it and then introduced first liquid and then gaseous nitrogen. Then to remove the nitrogen by boiling, they either warmed a thin platinum-wire in the liquid by an electric current, or they led gaseous hydrogen in, or finally gaseous oxygen into the solution. The last method was naturally the most convenient. They found that when liquid oxygen mixes with nitrogen a rise of temperature occurs, but the nitrogen can be completely boiled out of the mixture, though if liquid air is used the argon makes the separation more difficult.

**Autoxidation and Oxidation with Nitric Oxide.**—W Manchot.—In the autoxidation of organic compounds of the type $RH_2$, one molecule of hydrogen peroxide results from the absorption of one molecule of oxygen, according to the equation $RH_2 + O_2 = R + H_2O_2$. According to this equation the linking of two oxygen atoms in the oxygen molecule leads to the formation of the hydrogen peroxide. This assumption can be experimentally investigated, if instead of gaseous oxygen an oxidising agent is used in which no such linking can take place. Nitric oxide can be employed for this purpose, and the author has examined its action on oxanthranol and indigo-white, and has proved that no hydrogen peroxide is formed. The reaction was found to occur quantitatively according to the equation $RH_2 + 2NO = R + H_2O + N_2O$. These experiments are of great importance for the theory of autoxidation. They prove definitely that the formation of hydrogen peroxide in these processes is due to the fact that the chain of two atoms of oxygen preseut in the oxygen molecule remains intact during the reaction, and is still retained in the hydrogen peroxide.

**Sulphuric Acid Contact Process.**—Lothar Wöhler, A. Foss, and W. Plüddemann.—The authors have compared the catalytic effect of platinum as metal, monoxide, and dioxide, and have found that the monoxide at first shows only one-fifth of the activity of the metal; while the action of the metal remains nearly constant during an experiment, that of the monoxide is greatly increased till it is equal to the action of the metal. The action of the dioxide is even less than that of the monoxide, but it also increases. When palladium was substituted for platinum the results obtained were exactly analogous. If the catalytic action of the metal depended upon the intermediate formation of PtO or $PtO_2$ a better result would have been obtained by using the oxides than the metal, which is not the case. At first the action occurs according to the equation $PtO + SO_2 = SO_3 + Pt$, and then the metal is able to act catalytically. Thus the oxides of palladium and platinum are only pseudo-catalysers, *i.e.*, substances which by chemical reactions in the course of the process are converted into genuine catalysers. By investigating the action of the three metals, Pt, Pd, and Ir, at different temperatures between 450° and 750° on the contact mixture, the authors have deduced their curves of catalytic action. The temperature of maximum catalytic action is greatest with palladium and least with platinum, iridium being intermediate.

## MISCELLANEOUS.

**Cecil Medal and Prize.**—We wish to draw our readers' attention to an announcement in our advertising columns respecting the award of the Cecil Medal and a prize of £5 which are to be awarded in 1907 for the best paper on "Chemistry as Applied to Sanitation and Domestic Purposes, viz., Improved Cottages, Air, Water, and Drainage." There are few more useful applications of chemistry to the solution of social problems than those for which these prizes are to be awarded.

## MEETINGS FOR THE WEEK.

Monday, 26th.—Society of Arts, 8. (Cantor Lectures). "Artificial Fertilisers—their Nature and Functions," by A. D. Hall.

Wednesday, 28th.—Society of Arts, 8. "Patent Law Reform," by J. W. Gordon.


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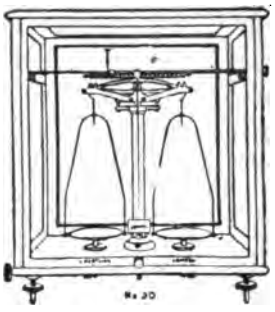

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Vol. XCIV., No. 2453.

# THE COLORIMETRIC DETERMINATION OF SMALL AMOUNTS OF GOLD.

By RALPH NELSON MAXSON.

Application of the colorimetric method for the estimation of small amounts of gold, based upon the purple of Cassius coloration, have been proposed by Carnot (*Comptes Rendus*, xcvii., 105, 169), Rose (Chemical News, lxvi., 271), Sonstadt (Chemical News, xxvi., 159), Cassel (*Eng. and Min. Journ.*, 76, xviii., 661), Prister (*Journ. Chem. Met. and Min. Soc. of South Africa*, 1903, iv., 235), Moir (*Journ. Chem. Met. and Min. Soc. of South Africa*, Sept., 1903), and others, but the use of this reaction for such a purpose is open to objection. According to the authority of other workers, the coloration thus produced is extremely variable, varying in intensity and shade according to the condition of the solution and precipitant. Moreover, the substance is unstable, and artificial standard solutions are necessary if accurate results are to be obtained.

It has been suggested that the coloration of red colloidal gold suspensions might have a quantitative relation to the amount of metal present, and a method of colorimetric estimation, free from the objections stated above, be based upon this relation. The following investigation was therefore undertaken in the hope of discovering whether such a relationship would not offer a suitable means for the estimation of small amounts of gold.

The preparation of the red colloidal suspensions was naturally the first object of interest. Blake (*Am. Journ. Sci.*, 1903, xvi., 381) has shown that acetylene is the most suitable reagent for effecting the reduction of the auric salt, the treatment consisting in drying the chloride at 170°, dissolving in ether, and pouring the ethereal solution into water also containing ether and saturated with acetylene gas. The use of ether was objectionable for the purpose of this investigation, and the simpler procedure described below gave good results.

The measured quantity of a standard solution of the auric salt was drawn off into a calibrated flask, and treated with a suitable amount of an aqueous solution of acetylene, made by dissolving the previously washed gas in water distilled and cooled in tin. The colour having developed, the solution was shaken, and the flask filled to the mark. The gold solutions used in these experiments were prepared from pure gold chloride, which contained hydrogen chloride in the usual amounts, and had not been subjected to a preliminary drying. The standard of these solutions was determined gravimetrically by means of magnesium ribbon, and by the electrolytic process with the revolving cathode. Solutions of less concentration were then obtained by suitable and accurate dilution.

A preliminary series of qualitative and quantitative experiments gave evidence that the coloration was of a quantitative nature, and that the suspensions were sufficiently stable under suitable conditions.

The Gallenkamp colorimeter was used in the subsequent quantitative experiments immediately following. The delicacy of the readings was increased by placing the instrument in a light-tight box pierced with suitably situated holes; the influence of external colours was avoided by admitting light to the instrument from a ground glass plate, which was found to be very efficient.

It is a well known fact that small amounts of electrolyte will rapidly change "red" gold to the "blue" modification. It is necessary therefore to conduct the comparisons n a room reasonably free from fumes, and to have all containing vessels free from soluble material. It was found that flasks which had been treated with steam for a few minutes gave the best results. Red suspensions contained in such flasks gave no trace of blue after an interval of several weeks.

Using the precautions outlined above, the results shown in Table I. were obtained. The error of the personal equation was determined by means of a series of comparisons conducted with different concentrations of the same suspension, and covering a range of amounts of material identical with the amounts handled in the experiments given below.

Table I.

| No. | Strength of solution. | Gold taken. | Gold found. | Error. | Gold in 1 c.c. of standard. |
|---|---|---|---|---|---|
| | Per cent. | Grm. | Grm. | Grm. | Grm. |
| 1. | 99·6 | 0·00080 | 0·00086 | +0·00006 | 0·000086 |
| 2. | 95·5 | 0·00077 | 0·00082 | +0·00005 | |
| 3. | 90·9 | 0·00075 | 0·00078 | +0·00003 | |
| 4. | 85·7 | 0·00073 | 0·00074 | +0·00001 | |
| 5. | 84·3 | 0·00071 | 0·00073 | +0·00002 | |
| 6. | 67·6 | 0·00062 | 0·00058 | −0·00004 | 0·000086 |
| 7. | 63·4 | 0·00058 | 0·00055 | −0·00003 | |
| 8. | 56·0 | 0·00054 | 0·00048 | −0·00006 | |
| 9. | 52·0 | 0·00052 | 0·00045 | −0·00007 | |
| 10. | 47·9 | 0·00047 | 0·00041 | −0·00006 | |
| 11. | 98·6 | 0·00081 | 0·00085 | +0·00004 | |
| 12. | 88·2 | 0·00075 | 0·00076 | +0·00001 | |
| 13. | 78·8 | 0·00070 | 0·00068 | −0·00002 | |
| 14. | 71·6 | 0·00065 | 0·00062 | −0·00003 | |
| 15. | 66·1 | 0·00059 | 0·00057 | −0·00002 | |
| 16. | 60·4 | 0·00054 | 0·00052 | −0·00002 | |
| 17. | 57·8 | 0·00048 | 0·00050 | +0·00002 | |
| 18. | 49·8 | 0·00043 | 0·00043 | 0·00000 | |
| 19. | 44·1 | 0·00038 | 0·00038 | 0·00000 | |
| 20. | 36·4 | 0·00032 | 0·00031 | −0·00001 | |
| 21. | 98·6 | 0·00081 | 0·00085 | +0·00004 | 0·000086 |
| 22. | 88·2 | 0·00075 | 0·00076 | +0·00001 | |
| 23. | 78·8 | 0·00070 | 0·00068 | −0·00002 | |
| 24. | 71·6 | 0·00065 | 0·00062 | −0·00003 | |
| 25. | 66·1 | 0·00059 | 0·00057 | −0·00002 | |
| 26. | 60·4 | 0·00054 | 0·00052 | −0·00002 | |
| 27. | 57·8 | 0·00048 | 0·00050 | +0·00002 | |
| 28. | 49·8 | 0·00043 | 0·00043 | 0·00000 | |
| 29. | 44·1 | 0·00038 | 0·00038 | 0·00000 | |
| 30. | 36·4 | 0·00032 | 0·00031 | −0·00001 | |
| 31. | 87·8 | 0·00030 | 0·00030 | 0·00000 | 0·000034 |
| 32. | 79·1 | 0·00028 | 0·00027 | −0·00001 | |
| 33. | 71·7 | 0·00026 | 0·00024 | −0·00002 | |
| 34. | 63·1 | 0·00024 | 0·00022 | −0·00002 | |
| 35. | 57·6 | 0·00022 | 0·00020 | −0·00002 | |
| 36. | 46·6 | 0·00019 | 0·00016 | −0·00003 | 0·000034 |
| 37. | 44·6 | 0·00017 | 0·00015 | −0·00002 | |
| 38. | 35·8 | 0·00015 | 0·00012 | −0·00003 | |
| 39. | 28·9 | 0·00013 | 0·00010 | −0·00003 | |
| 40. | 16·4 | 0·00004 | 0·00006 | +0·00002 | 0·000034 |
| 41. | 21·9 | 0·00007 | 0·00007 | 0·00000 | |
| 42. | 25·9 | 0·00009 | 0·00009 | 0·00000 | |
| 43. | 36·9 | 0·00011 | 0·00013 | +0·00002 | |
| 44. | 46·5 | 0·00013 | 0·00016 | +0·00003 | |
| 45. | 38·3 | 0·00015 | 0·00013 | −0·00002 | |
| 46. | 47·3 | 0·00017 | 0·00016 | −0·00001 | |
| 47. | | (Lost by accident). | | | |
| 48. | 56·8 | 0·00022 | 0·00019 | −0·00003 | |
| 49. | 66·1 | 0·00024 | 0·00023 | −0·00001 | |

The forty-nine analyses given in the table were made under widely varying conditions. The age of the suspensions varied from a few minutes to several weeks. In order to avoid error of measurement, new standard suspensions were prepared from time to time, and their concentrations are shown in the last column of the table.

The analyses covered a wide range in amounts of gold, and were conducted under varying conditions of light. The results are seen to run with fair regularity, and the errors are approximately of the same order of magnitude.

The Gallenkamp colorimeter, used in the foregoing experiments, is not only expensive but cumbersome and complicated in construction; moreover, the instrument is not suitable for the correct estimation of the most minute amounts of gold, the colour becoming too faint for accurate comparison because of the shortness of the columns of liquid. A modified form of the type of apparatus proposed by Penfield for the colorimetric estimation of titanium, and consisting of comparison tubes set vertically in a dark box and illuminated from below, was therefore adopted. The tubes used in these comparisons had a diameter of 1 c.m. and a length of 13 c.m., and were accurately graduated to hold 10 c.c.

A mirror suitably situated beneath the box containing the tubes gave efficient illumination. Such an apparatus is not only cheaply and easily procured, but if tubes of these dimensions are used it is capable of accurately determining very small amounts of gold.

The method of comparison was carried out in the following manner:—A measured amount of the suspension was drawn off into the left-hand tube and diluted to the mark with water; a suitable amount of water was then placed in the right-hand tube, and the standard suspension drawn into the tube until the colours were seen to be identical. The necessary amount of water to be used can be determined by preliminary experiment.

The positions of the tubes were always reversed before the final reading was taken.

The following experiments were made in order to determine the error and range of amounts of gold capable of accurate estimation in such an apparatus with tubes of the dimensions described above. The comparisons were made with a red suspension prepared by careful dilution of a more concentrated standard suspension which contained 0·000010175 grm. of metal in 1 c.c.

The results obtained with different concentrations of the standard suspension just described are given in Table II.

TABLE II.

| No. of analysis. | Gold suspension taken. | Gold suspension used. | Gold used. | Gold found. | Error. |
|---|---|---|---|---|---|
| | C c. | C.c. | Grm. | Grm. | Grm. |
| 1. | 9·50 | 9·05 | 0·000102 | 0·000097 | - 0·000005 |
| 2. | 8·00 | 7·59 | 0·000086 | 0·000082 | - 0·000004 |
| 3. | 7·00 | 6·89 | 0·000075 | 0·000074 | - 0·000001 |
| 4. | 6·00 | 5·83 | 0·000065 | 0·000063 | - 0·000002 |
| 5. | 5·00 | 4·84 | 0·000054 | 0·000052 | - 0·000002 |
| 6. | 4·00 | 3·88 | 0·000043 | 0·000042 | - 0·000001 |
| 7. | 3·00 | 2·47 | 0·000032 | 0·000027 | - 0·000005 |
| 8. | 2·00 | 1·82 | 0·000022 | 0·000020 | - 0·000002 |
| 9. | 1·00 | 0·93 | 0·000011 | 0·000010 | - 0·000001 |

The intensity of the colour in the above experiments ranged from a deep red to a faint pink. Further comparisons made with suspensions more dilute than those described above gave errors of magnitude increasing with the dilution. The amounts handled here are, then, the minimum quantities that can be accurately estimated with the apparatus described. It is obvious that if larger amounts of the metal are to be determined, tubes of greater dimensions should be used.

The application of such a method for the determination of gold naturally starts with that element. The weighed amount of metal, contained in a clean porcelain crucible, can be readily brought into solution with the aid of chlorine water or aqua regia, and the excess of the solvent evaporated off upon the water-bath. Experiments have shown that a gentle preliminary heating of the solution of the auric salt hastens the rapidity of the reduction. Care must be taken not to reduce any of the gold chloride by such a procedure.

If traces of electrolyte are present the coagulation of the "red" gold may be sometimes avoided by the addition of a few drops of ether to the cold solution. When small amounts of the metal are handled the volume of the solution should not exceed a few c.c., and only a small amount of the aqueous solution of acetylene should be added; otherwise the coloration may be partially or totally inhibited.

In conclusion, it can be seen from the evidence of the experiments described above, that the colorimetric estimation of small amounts of gold is quantitatively possible if proper precautions are taken to ensure the maximum coloration and exclusion of electrolytes. The method is quick and simple in character, and for the amounts of gold used above, the results show it to possess suitable accuracy for the correct estimation of small amounts of the metal.

The author wishes to acknowledge his indebtedness for much helpful aid and advice in this, and in previous work, to Prof. Gooch, at whose suggestion these experiments have been carried on.—*American Journal of Science*, xxi., p. 270.

## THE VOLHARD METHOD FOR THE DETERMINATION OF CHLORINE IN POTABLE WATERS.

By FRANK T. SHUTT, M.A., F.I.C.,
and
H. W. CHARLTON, B.A.Sc.

In judging of the purity of a water supply the chlorine content, as is generally admitted, is a factor of the greatest importance. It is of especial value when comparing waters from adjacent sources or those collected at different points from the same source—as from a river or lake. In such cases a difference of a few parts per million of chlorine may be sufficient to establish sewage contamination. It becomes, therefore, a matter of the greatest consequence that the water analyst should be possessed of a process whereby he can determine the chlorine with accuracy.

The process practically in universal use for the estimation of chlorine in waters is that known as the "chromate" method—a description of which is to be found in all works on water analysis. In the majority of cases this method is eminently satisfactory, but there are some waters with which it fails to give a sufficiently close reading for diagnostic purposes, and again others with which it is altogether impossible to obtain a definite end reaction. We have, for instance, found that the chromate method is extremely unsatisfactory, practically valueless, for many "upland surface" waters, namely, those brown from dissolved peaty matter and characterised by a low chlorine content.

To learn if more satisfactory results could not be obtained, particularly with peaty waters, we recently adapted the Volhard method, and have since examined by it more than sixty samples representative of all classes of potable waters. In this we have met with gratifying success, for in no case has it been found to fail. Duplicate determinations agree very well, the end reaction being sharp and easily noted. Indeed, it is safe to say that if the Volhard were as rapid as the chromate method it would soon replace it. Our opinion is, however, that its usefulness is rather as an auxiliary or supplementary method than one to replace entirely the older process.

### *The Volhard Method.*

*Solutions.*—The same silver nitrate solution is used as is employed in the chromate method, viz., of such a strength that 1 c.c. = 0·001 chlorine.

A solution of potassium sulphocyanide, of such a strength that 1 c.c. corresponds to 1 c.c. of the silver nitrate solution. (NOTE.—Ammonium sulphocyanide cannot be used).

Nitric acid (three volumes of acid to one of water). This is boiled to expel oxides of nitrogen. This, as also the above solutions, should be kept in the dark.

The indicator is made by dissolving ferrous sulphate in water and completely oxidising by nitric acid on the water-bath. It is then evaporated to dryness repeatedly with a

little concentrated sulphuric acid to expel the excess of nitric acid, and ferric carbonate added to neutralise the sulphuric acid. The solution is then filtered and is ready for use.

*Modus operandi.*—100 c.c. of the water to be examined are poured into a beaker and 5 c.c. to 10 c.c. of the nitric acid added. Then, from a 2 c.c. pipette graduated to 1/50 c.c., a slight excess of silver nitrate solution is added. After a few minutes, the precipitated chloride is filtered out and well washed, the filtrate being received in a porcelain basin. (The filter-pump may frequently be used to advantage). To this is now added one c.c. of the indicator and the potassium sulphocyanide solution run in (from a similar pipette to that used with the silver nitrate) until a faint red colour is permanently produced. The end-point is sharp and easily noted. The difference between the number of cubic centimetres of the silver nitrate and of the potassium sulphocyanide solutions used represents the number of cubic centimetres of the former required by the chlorine in 100 c.c. of the water.

To ascertain the relative accuracy of the chromate and Volhard methods, a series of determinations were made on certain dilute solutions of chemically pure sodium chloride, with the results given in Table I.

TABLE I.—*Chlorine (Parts per Million).*

| Chlorine added as sodium chloride. | Found by Volhard method. | Found by chromate method. |
|---|---|---|
| 36·4 | 36·8 | 37·5 |
| 24·3 | 24·8 | 26·0 |
| 13·1 | 13·0 | 14·0 |
| 12·1 | 12·2 | 14·0 |
| 6·1 | 6·7 | 7·0 |
| 6·0 | 6·5 | 7·0 |
| 3·6 | 3·8 | 4·6 |
| 3·6 | 3·5 | 4·8 |
| 2·4 | 2·5 | 3·3 |
| 1·2 | 1·25 | 0·5 |
| 1·2 | 1·0 | 0·6 |
| 0·6 | 0·5 | Could not be determined with precision. |
| 0·6 | 0·5 | |
| 0·5 | 0·6 | |
| 0·25 | 0·125 | |
| 0·25 | 0·175 | |

These data are sufficient, we think, to show the extreme sensitiveness of the Volhard method and also its superiority to the chromate process, especially when very small amounts of chlorine are to be determined.

Some of our earlier trials with this method were made on upland peaty waters—a class with which, as we observed, it is very difficult to obtain satisfactory results by the older process. The accompanying series (Table II.), consisting of samples taken from various points on the same river, very well illustrates the value of the Volhard method. All the waters were quite brown from the presence of dissolved peaty matter, but with the Volhard process this high colour did not interfere with the end reaction, as happened when using the chromate method.

TABLE II.—*Analysis of Peaty Waters (Results in Parts per Million).*

| | Free ammonia. | Albumenoid ammonia. | Nitrogen as nitrites and nitrates. | Chlorine by— Volhard. | Chlorine by— Chromate. | Solids. At 212° F. | Solids. After ignition. |
|---|---|---|---|---|---|---|---|
| A. | 0·06 | 0·133 | 0·092 | 2·3 | 1·9 | 70·0 | 36·4 |
| B. | 0·088 | 0·166 | 0·0297 | 2·3 | 1·6 | 75·6 | 35·8 |
| C. | 0·03 | 0·14 | 0·0294 | 2·2 | 1·3 | 69·2 | 33·2 |
| D. | Free | 0·138 | 0·05 | 1·6 | 0·95 | 64·4 | 32·4 |
| E. | 0·01 | 0·24 | 0·024 | 2·0 | 0·64 | 75·2 | 32·0 |
| F. | 0·044 | 0·256 | 0·0131 | 2·5 | 0·61 | 64·8 | 34·8 |
| G. | 0·05 | 0·208 | 0·0082 | 2·2 | 0·60 | 75·2 | 31·2 |

Comparing the chlorine values, it will at once be seen that the Volhard results allow a much closer discrimination than is possible from those of the chromate method. In this instance they were instrumental in establishing the entrance of sewage at a certain point in the course of the river—a fact which the chromate data were quite incapable of showing.

The results given in Table III. have been taken seriatim from our analysis book, and constitute about two-thirds of the waters examined by the Volhard process to date. The waters are from all sources and come from all parts of the Dominion. Among them are representatives of the polluted barnyard well, of pure spring waters, of river and lake waters, and of waters charged with saline matter and occasionally sulphuretted hydrogen.

TABLE III.—*Chlorine in Potable Waters (Parts per Million).*

| No. | By chromate method. | By Volhard method. |
|---|---|---|
| 1. | 32·0 | 31·2 |
| 2. | 38·0 | 40·0 |
| 3. | 22·0 | 22·5 |
| 4. | * | 3·5 |
| 5. | 90·0 | 90·0 |
| 6. | 45·0 | 45·0 |
| 7. | 80·0 | 80·0 |
| 8. | 5·0 | 4·5 |
| 9. | 39·0 | 45·0 |
| 10. | 19·0 | 18·0 |
| 11. | 142·5 | 140·0 |
| 12. | 18·0 | 18·0 |
| 13. | 9·5 | 8·0 |
| 14. | 26·0 | 25·0 |
| 15. | 85·0 | 82·0 |
| 16. | * | 4·5 |
| 17. | 17·0 | 16·2 |
| 18. | 17·0 | 16·0 |
| 19. | * | 0·6 |
| 20. | 100·0 | 102·0 |
| 21. | 9·0 | 8·7 |
| 22. | 5·0 | 4·5 |
| 23. | 95·0 | 95·0 |
| 24. | 30·0 | 28·2 |
| 25. | 58·0 | 60·0 |
| 26. | 32·0 | 29·2 |
| 27. | 1·0 | 1·5 |
| 28. | * | 16·0 |
| 29. | 3·2 | 3·0 |
| 30. | 255·0 | 252·0 |
| 31. | 3·0 | 2·0 |
| 32. | 1800·0 | 1750·0 |
| 33. | 200·0 | 175·0 |
| 34. | 510·0 | 505·0 |
| 35. | * | 1·0 |
| 36. | 165·0 | 162·0 |
| 37. | 13·0 | 13·0 |
| 38. | 3·5 | 2·8 |
| 39. | * | 32·0 |
| 40. | 34·0 | 29·0 |

In the waters marked * the chlorine could not be determined with any degree of accuracy by the chromate method.

In a large number of these examples the results by the chromate method are sufficiently accurate for ordinary purposes, but the very fact that among these waters there were five the chlorine of which could only be satisfactorily determined by the Volhard process emphasizes the value of this latter method for water analysis.

It is to be observed that the particular usefulness and accuracy of this process is with waters containing very small amounts of chlorine—a fact which enhances its importance for the examination of upland surface waters, which are naturally low in chlorides.

In the Volhard method no check or blank is required, and hence one source of error is avoided. In the chromate method the check may require from 0·2 to 0·5 c.c. silver

nitrate solution, according to the character of the distilled water. This means, if only 10 c.c. of the water were under examination, a possible error of 30 parts per million.

With the chromate method 100 c.c. of the water sample is commonly employed for the titration, smaller quantities being taken of waters with high chlorides and made up to that volume. The Volhard does not necessitate any fixed volume for titration, and experience has shown that the filtrate and washings may vary from 80 c.c. to 120 c.c. without affecting in the least the results.

Our custom now in the laboratories of the Experimental Farms is to examine all the waters received for analysis by the chromate method; if a satisfactory end reaction is obtained the results are accepted as correct. If, however, difficulty is met with in this particular the Volhard process is employed, and in no instance has the latter failed to give a reading at once clear and decisive.—*Transactions of the Royal Society of Canada*, xi., p. 67.

## A REVISION OF THE ATOMIC WEIGHT OF BROMINE.*

By GREGORY PAUL BAXTER.

In numerous investigations in this laboratory upon the atomic weights of certain metals, in which metallic bromides were first titrated against the purest silver, and then the precipitated silver bromide was collected and weighed, the relation between the silver used in the titrations and the silver bromide obtained has yielded data from which the atomic weight of bromine may be calculated. Furthermore, in all these investigations, as a check upon the purity of the silver and bromine employed, silver bromide was synthesised directly from weighed quantities of silver and an excess of ammonium bromide or hydrobromic acid. Many of these results have already been collected and discussed by Richards (*Proc. Am. Phil. Soc.*, 1904, xliii., 119); nevertheless, they are cited in the accompanying table together with a few more recent determinations.

From the first of these ratios the atomic weight of bromine, referred to silver 107·930, is found to be 79·956, and from the second 79·955.

Very recently, in experiments in which silver iodide was heated first in a current of air and bromine until the iodine was completely displaced, and then in a current of chlorine to displace the bromine, the ratio of silver bromide to silver chloride was determined in six cases. From the results of these experiments the atomic weight of bromine was calculated to be 79·953 (Baxter, *Journ. Am. Chem. Soc.*, 1905, xxvii., 884), if the atomic weight of chlorine is assumed to be 35·473 (Richards and Wells, Publications of the Carnegie, Institution, 1905, No. 28; *Journ. Am. Chem. Soc.*, xxvii., 459).

These values for bromine are in close agreement with those of Stas ("Œuvres Complètes," i., 603). In his experiments weighed quantities of pure silver and bromine were first titrated against each other, and then the precipitate of silver bromide was collected and weighed. Of the four results by the first method, one should be rejected according to his own statements, since the bromine was not thoroughly dried. The remaining three, 79·959, 79·961, and 79·960, gave as an average 79·960. From the weight of silver bromide four values were obtained, 79·950, 79·952, 79·955, and 79·957, with an average of 79·954.

Marignac ("Œuvres Complètes," i., 181) also determined the ratio of silver to silver bromide, with somewhat lower results—79·959, 79·941, and 79·952; average, 79·950.

Scott (*Journ. Chem. Soc.*, 1901, lxxix., 147), in his analysis of ammonium bromide, obtained six values for the same ratio, varying between 79·936 and 79·948, with an average of 79·943. One of his results is here rejected, since the silver used in this experiment was known to be impure.

| | Bromide analysed. | Number of experiments. | Ratio, Ag : AgBr. |
|---|---|---|---|
| | *Indirect Determinations.* | | |
| 1. | $BaBr_2$ | Last seven | 57·444 |
| 2. | $SrBr_2$ | Seven | 57·444 |
| 3. | $ZnBr_2$ | One | 57·445 |
| 4. | $NiBr_2$ | Seven | 57·444 |
| 5. | $CoBr_2$ | Last five | 57·446 |
| 6. | $UBr_4$ | Three | 57·447 |
| 7. | $CsBr$ | Three | 57·444 |
| 8. | $FeBr_2$ | Two | 57·443 |
| 9. | $CdBr_2$ | Eight | 57·444 |
| 10. | $MnBr_2$ | Thirteen | 57·444 |
| | Average, weighted according to the number of determinations | | 57·4443 |
| | *Direct Determinations.* | | |
| 11. | $HBr$ | Two | 57·445 |
| 12. | $NH_4Br$ | One | 57·446 |
| 13. | $HBr$ | Two | 57·444 |
| 14. | $NH_4Br$ | One | 57·445 |
| 15. | $NH_4Br$ | One | 57·444 |
| 16. | $NH_4Br$ | Two | 57·447 |
| 17. | $NH_4Br$ | Three | 57·444 |
| 18. | $NH_4Br$ | One | 57·443 |
| | Average, weighted according to the number of determinations | | 57·4447 |

*Analyst and Reference.*

1. Richards, *Proc. Am. Acad.*, xxviii., 28.
2. Richards, *Ibid.*, xxx., 389.
3. Richards, *Ibid.*, xxxi., 178.
4. Cushman, *Ibid.*, xxxiii., 111.
5. Baxter, *Ibid.*, xxxiii., 127.
6. Merigold, *Ibid.*, xxxvii., 393.
7. Archibald, *Ibid.*, xxxviii., 466.
8. Baxter, *Ibid.*, xxxix., 252.
9. Hines, *Journ. Am. Chem. Soc.*, xxviii., 783.
10. Hines (not yet published).
11. Richards, *Proc. Am. Acad.*, xxviii., 17, 18.
12. Richards, *Ibid.*, xxx., 380.
13. Richards, *Ibid.*, xxxi., 165.
14. Cushman, *Ibid.*, xxxiii., 106.
15. Baxter, *Ibid.*, xxxiii., 122.
16. Baxter, *Ibid.*, xxxiv., 353.
17. Baxter, *Ibid.*, xxxix., 250.
18. Hines (not yet published).

Dumas (*Ann. Chem. Pharm.*, 1860, cxiii., 20), by heating silver bromide in chlorine, found the values 80·06, 79·89, and 79·96.

In computing the atomic weight of bromine from these data, great weight is always given to Stas's determinations, the value 79·955 being usually assumed as the most probable one for the constant in question. Certainly, as pointed out by Richards (*Proc. Am. Phil. Soc.*, 1904, xliii., 119), the true value must lie between 79·95 and 79·96. Clarke calculates the value 79·949 as the weighted average of the difference investigated previous to Scott's ("A Re-calculation of Atomic Weights," Smith. Misc. Coll., 1897).

Considerable uncertainty exists as to the purity of the materials employed in much of the foregoing work. Richards and Wells have already exhaustively investigated the various methods of preparing pure silver, and have found that while it is a comparatively simple matter to free this substance from metallic impurities, the absence of gaseous impurities is by no means so easy to secure

* From the *Journal of the American Chemical Society*, xxviii., No. 10.

(Publications of the Carnegie Institution, No. 28, 16; also *Journ. Am. Chem. Soc.*, 1905, xxvii., 472). Oxygen may be eliminated best by fusion in an atmosphere of pure hydrogen gas (Baxter, *Proc. Am. Acad. Arts Sci.*, 1903, xxxix., 249), or by prolonged fusion in a vacuum, while a lime-boat was found to be the most suitable support for the silver during fusion.

In most of the experiments cited on page 202, one of the final steps in the purification of the silver was fusion of electrolytic crystals on lime, in many cases in a vacuum, but without especial care to prolong the fusion. Silver prepared in this way was found by Richards and Wells to contain traces of oxygen, derived from silver nitrate occluded by the electrolytic crystals. In cases 8, 9, 10, 17, and 18, however, the silver was fused in hydrogen. Richards and Wells showed also that Stas's silver contained at least 0·01 per cent of impurity, since it yielded 0·01 per cent less silver chloride than their purest silver (*loc. cit.*, p. 62). Scott's silver in three cases was merely heated, not fused, in hydrogen, and in two of the others was fused before a blowpipe on calcium phosphate. In one experiment only the metal was fused on lime. No details are given as to the purification of the silver used by Marignac.

Bromine also may be freed from impurities only with some difficulty. Experience in this laboratory has shown that chlorine may be eliminated most conveniently by distilling or precipitating the bromine from solution in a bromide. One such distillation is sufficient to remove chlorine completely only when the substance is initially comparatively pure. If, however, the process is repeated by converting a portion of the partially purified product into a bromide, and dissolving the remainder of the bromine in this comparatively pure bromide, the chlorine is eliminated so completely that further repetitions of this process have no apparent effect. (Attention has already been called to these points by Richards and Wells, *Proc. Am. Acad. Arts Sci.*, 1906, xli., 440). The removal of iodine may be easily effected by converting the bromine into hydrobromic acid or a soluble bromide, and boiling the solution with a small quantity of free bromine. Here again it is well to repeat the process several times, since the reaction between free bromine and the iodine ion, like that between free chlorine and the bromine ion, is undoubtedly incomplete.

The greater part of the experiments cited above were made with bromine which had been purified with due observance of these precautions. Of the other investigators, Stas seems to have been the only one to use sufficient pains to secure purity of the bromine. Stas removed iodine by shaking potassium bromide several times with free bromine and carbon disulphide, and in the course of the prolonged purification distilled the bromine twice from solution in a bromide. Marignac's purification consisted solely in crystallisation of barium bromate and Scott's in distillation of hydrobromic acid.

Of the methods employed in these early determinations, that involving the analysis of metallic halides is least suited for the purpose, on account of the danger of occlusion of metallic salts by the precipitated silver bromide. That such an error actually exists to a slight extent is shown by the fact that the average of the "indirect" determinations is slightly larger than the average of the "direct" determinations. Obviously, if silver bromide is precipitated by means of either ammonium bromide or hydrobromic acid, occluded ammonium salts or free acids could be easily expelled by fusion of the bromide. This precaution was observed in most of the determinations recorded on page 202, and is absolutely essential for the complete elimination of water from the salt. Stas and Marignac both fused the silver bromide in their syntheses, but this precaution was omitted by Scott, who dried the bromide at 180°. Scott's statement that the loss on fusion of silver bromide which bad been dried at 180° was due to the presence of asbestos is contradicted by the experiments recorded later in this paper, in which the loss on fusion amounted to about 0·01 per cent in the case of silver bromide which had been dried in a similar fashion, and which was almost entirely free from asbestos.

From this brief discussion of the more important errors which may have influenced previous determinations of the atomic weight of bromine, it is evident that some uncertainty still exists as to the true value of this constant. In the hope of throwing new light upon the subject, experiments were carried out by two of the methods outlined above, with especial precautions to insure purity of materials and to eliminate known possible errors in the experimental methods.

Both the methods chosen—synthesis of silver bromide from a weighed amount of silver, and conversion of silver bromide into silver choride—have already been recently tested in this laboratory, and have been found to be at least as satisfactory as any (Baxter, *Proc. Am. Acad. Arts Sci.*, xl., 419; xli., 73; Richards and Wells, Publications of the Carnegie Institution, No. 28; *Journ. Am. Chem. Soc.*, 1905, xxvii., 876).

### *Purification of Materials.*

*Bromine.*—In purifying bromine for this research, the principles set forth above of this paper were applied, but in some cases the purifying processes were repeated after the product was apparently pure, in order to make certain that further treatment had no effect.

Sample I. was first completely dissolved in calcium bromide which had been made from about one-third of the original material by means of lime and ammonia, and was then distilled from the solution. The product was covered with several times its volume of water, and was converted into hydrobromic acid by means of pure hydrogen sulphide which had been generated from ferrous sulphide with dilute sulphuric acid, and which had been thoroughly washed with water. After filtration from the precipitated sulphur and bromide of sulphur, the acid was boiled for some time, with occasional addition of small quantities of re-crystallised potassium permanganate to eliminate the iodine. Finally, the residual hydrobromic acid was heated with an equivalent amount of re-crystallised permanganate, and the bromine was condensed in a flask cooled with ice.

Sample II. was first converted into hydrobromic acid by means of red phosphorus and water, and the hydrobromic acid was then distilled, after having been boiled with an excess of bromine. An equivalent amount of permanganate was added, and the bromine liberated was separated from the solution by distillation. About one-fourth of the product was next transformed into calcium bromide by means of ammonia and lime which was free from chloride, and the remaining three-fourths of the bromine were dissolved in the calcium bromide and distilled. Still a third distillation from a bromide was carried out by reducing the product of the second distillation with hydrogen sulphide, and subsequently oxidising the hydrobromic acid with the purest re-crystallised potassium permanganate, after boiling the acid with several small portions of permanganate to eliminate the last traces of iodine.

Sample III. was obtained by preparing calcium bromide from a portion of Sample II. and distilling the remainder of Sample II. from solution in this bromide.

In the case of Sample IV. the processes of reduction to hydrobromic acid with hydrogen sulphide and oxidation of the hydrobromic acid with pure permanganate were four times repeated. After each reduction the hydrobromic acid was boiled with free bromine to remove iodine.

Sample V. was three times reduced with hydrogen sulphide and oxidised with permanganate. One-fourth the product was converted into calcium bromide and the remainder was dissolved in this calcium bromide and distilled.

Thus, Sample I. was twice distilled from a bromide; Sample II. was treated three times in the same way; and Sample III., IV., and V. four times.

Shortly before use each sample was distilled and converted into ammonium bromide by slow addition to an

excess of re-distilled ammonium hydroxide. The solution was then boiled to expel the excess of ammonia.

*Silver.*—Several different samples of silver were employed, many of which have already been used in atomic weight researches in this laboratory, and have shown evidence of great purity. For details concerning the purification the papers referred to should be consulted.

Sample A was employed in a determination of the atomic weight of iodine (Baxter, *Proc. Am. Acad. Arts Sci.*, 1904, xl., 420; *Journ. Am. Chem. Soc.*, 1905, xxvii., 881). This specimen had been twice precipitated as chloride, and once electrolysed.

Sample B was used in experiments upon the atomic weight of iodine (Baxter, *Proc. Am. Acad. Arts Sci.*, 1905, xli., 79; *Journ. Am. Chem. Soc.*, 1905, xxvii., 881) and of manganese (Baxter and Hines, this paper will soon be published). It was precipitated once as chloride, electrolysed once, and finally precipitated as metal with ammonium formate.

Sample C also was employed in a determination of the atomic weight of manganese, and was purified by re-crystallising silver nitrate, seven times from nitric acid, and five times from aqueous solution. Finally, the silver nitrate was reduced by means of ammonium formate.

Sample D was prepared for the determination of the atomic weights of cadmium (Baxter and Hines, *Journ. Am. Chem. Soc.*, 1906, xxviii., 772; Chemical News, xciv., p. 224 *et seq.*) and manganese, by one precipitation as chloride, one precipitation with ammonium formate, and one electrolysis.

Sample E was first purified in part by precipitation as chloride, in part by precipitation with ammonium formate. The combined material was then subjected to two electrolyses.

In all cases the electrolytic crystals were fused in a boat of the purest lime, contained in a porcelain tube, in a current of electrolytic hydrogen. After the buttons had been cleansed with dilute nitric acid and dried at 200°, they were cut into fragments of from 4 to 8 grms. either by means of a clean chisel and anvil or with a fine jeweller's saw. The latter method was employed in the case of Samples D and E, because it proved easier completely to free the silver from surface contamination with iron by etching the fragments with nitric acid, than when a chisel was used. The cleansing process with nitric acid was repeated until the solution thus obtained, after precipitation with hydrochloric acid and evaporation, proved free from iron. That every trace of iron could be removed by this treatment was proved by testing for iron the evaporated filtrates from several of the analyses subsequently recorded in this paper. Negative results were obtained in all cases.

After thorough washing with water and drying at 100°, the pieces of metal were heated to about 400° in a vacuum, and were preserved over solid potassium hydroxide in a desiccator.

### *The Ratio of Silver to Silver Bromide.*

The ratio of silver to silver bromide was determined as follows:—Weighed quantities of silver were dissolved in the purest re-distilled nitric acid, diluted with an equal volume of water, in a flask provided with a column of bulbs to catch possible spatterings. However, during the solution of the silver the temperature was kept so low that almost no gas was evolved, and hence there was very little danger from this source. Next the acid solution of the silver was diluted with an equal volume of water, and was heated until free from nitrous acid and oxides of nitrogen. After still further dilution, the solution was added slowly with constant agitation to a dilute solution of an excess of ammonium bromide in a glass-stoppered precipitating flask, and the whole was violently shaken for some time to promote coagulation. By adding the silver solution to the bromide, occlusion of silver nitrate was almost wholly precluded. In some experiments the solutions were as dilute as twentieth-normal, in others as concentrated as fourth-normal. The final results seemed to be independent of the concentration of the solutions. At the end of about twenty-four hours the flask with its contents was again shaken, and then it was allowed to stand until the supernatant liquid was perfectly clear. The precipitate of silver bromide was collected upon a weighed Gooch crucible, after thorough washing by decantation with water, and was dried in an electric oven, first for several hours at 130°, finally for about fourteen hours at 180°. Then it was cooled and weighed.

The operations of precipitation and filtration were performed in a large cupboard lighted with red light, and if the flask was taken out of this cupboard it was enveloped in several thicknesses of black cloth.

Even after the prolonged drying, traces of moisture were retained by the salt, and could be expelled only by fusion. This was done by transferring the bulk of the silver bromide, freed as completely as possible from asbestos, to a small porcelain crucible which was weighed with its cover. The silver bromide was then fused by heating the small crucible, contained in a large crucible to prevent direct contact with the flame of the burner. A temperature much above the fusing-point of silver bromide was avoided so that the volatilisation of the salt could not take place. This treatment must have eliminated occluded ammonium salts as well as water. Finally, in order to convert any occluded silver nitrate, metallic silver, or silver sub-bromide into silver bromide, the salt was again fused in a current of dry air containing bromine vapour. This treatment seldom produced any measurable effect either upon the weight or the appearance of the salt, which was perfectly transparent and of a light yellow colour even after the first fusion in air.

A few shreds of asbestos displaced from the crucible, together with an occasional trace of silver bromide which escaped the crucible, were collected upon a tiny filter-paper, which was then ignited in a porcelain crucible. Before being weighed the ash was either treated with a drop of nitric and hydrobromic acids, and again heated, or else was heated for some minutes in a current of air and bromine.

The filtrate and washings were evaporated to small bulk. The precipitating flask and all other glass vessels used in the analysis were rinsed with ammonia, and the rinsings were added to the evaporated filtrate and wash-waters. The whole was then tested in a nephelometer for silver and the quantity found was estimated by comparison with standard silver solutions. In most cases the correction thus obtained was less than 0·1 m.grm.

The asbestos which formed the felt in the Gooch crucible, after having been shredded, was digested for some hours with aqua regia and was then thoroughly washed with water. Before the empty crucible was weighed the felt was ignited with a Bunsen burner. Crucibles thus treated and then heated to 180° after being moistened with water did not change in weight.

In Table I. are cited all the analyses which were completed without accident. Vacuum corrections of −0·000031 for every apparent grm. of silver and of +0·000041 for every apparent grm. of silver bromide are applied. The atomic weight of silver is assumed to be 107·930.

(The specific gravity of the weights was determined to be 8·3. The specific gravity of silver has been found to be 10·49—Richards and Wells, Publications of the Carnegie Institution, No. 28, 11. The specific gravity of fused silver bromide has been found to be 6·473—Baxter and Hines, *Am. Chem. Journ.*, xxxi., 224).

The platinum plated brass weights were standardised from time to time, and were found to retain their original values within a very few hundredths of a milligrm. in all cases.

(To be continued).

# PROCEEDINGS OF SOCIETIES

## CHEMICAL SOCIETY.

*Ordinary Meeting November 15th, 1906.*

Prof. R. MELDOLA, F.R.S., President, in the Chair.

MESSRS. J. Campbell Brown and W. H. Hurtley were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Frank Stanley Benton, Hurstead, Reigate; John Trevor Cart, B.Sc., A.I.C., 4, Simonside Terrace, Heaton, Newcastle-on-Tyne; George William Clough, B.Sc., 29, Oseney Crescent, N.W.; Victor George Jackson, 21, Frankfurt Road, Herne Hill, S.E.; Louis Murgatroyd, 1, Carlton Drive, Heaton, Bradford; Robert Robertson, M.A. D.Sc., F.I.C., 9, Sewardstone Road, Waltham Abbey; Arthur Henry Salway, Ph.D., B.Sc., 15, Palmerston Road, Forest Gate, E.; Robert Low Smith, 56, Genesta Road, Plumstead, S.E.; William Sandilands Templeton, M.A., B.Sc., Colombo, Ceylon; Maximilian Toch, 261, West 71st Street, New York City, U.S.A.

A certificate was authorised by the Council for presentation to ballot under By-law I. (3) in favour of Tarak Nath Majumdar, 37, Lower Chitpore Road, Calcutta, India.

Of the following papers, those marked * were read:—

*203. "*The Determination of the Rate of Chemical Change by Measurement of Gases Evolved.*" (Preliminary Notice). By FRANCIS EDWARD EVERARD LAMPLOUGH.

The most important results of this investigation may be summarised as follows:—

When a chemical reaction takes place in solution resulting in the formation of a substance which is gaseous at the ordinary temperature, the solvent becomes supersaturated with the gas.

The degrees of supersaturation may be so great that the solvent contains one hundred times the normal amount of the gas, and from such a solution the gas is gradually evolved.

The excess of gas so dissolved may be almost entirely expelled in thirty seconds by briskly agitating the liquid.

Investigation of the rate of decomposition of hydrogen peroxide showed that under such conditions of efficient stirring, the rate of evolution of a gas furnishes an accurate and reliable method of investigating reactions of this nature.

The decomposition of diazobenzene chloride was shown to be strictly a unimolecular reaction throughout, the rate of which is independent of the amount of acid present. The value of the constant for the reaction was found to vary with change of temperature, increasing logarithmically with increase of temperature.

The nature of the decomposition of ammonium nitrite most nearly approaches that of a quadrimolecular reaction throughout the extent of decomposition investigated.

The decomposition of formic acid by sulphuric acid is a true unimolecular reaction, and not bimolecular, as it has been hitherto considered.

The reaction between nickel carbonyl and iodine has also been studied.

### DISCUSSION.

Dr. CAIN pointed out that Hantzsch had first shown that the value of the constant obtained in measurements of the rate of decomposition of diazo solutions was low at the beginning of an experiment, owing to the solubility of the nitrogen. There was no supersaturation, however, in the solutions used in the experiments by him (Dr. Cain) and Mr. Nicoll, for the deficit in the quantity of nitrogen evolved corresponded to the amount which would ordinarily remain in solution. Moreover, the values obtained for the constants agreed well with those given by Hantzsch, Euler, and other investigators.

Mr. CALDWELL asked if there were any *real* retardation of these reactions when the solutions were not stirred. The accumulation of large amounts of the gaseous product existing in a highly supersaturated state in the solution might tend to make a reaction reversible.

Mr. LAMPLOUGH, in reply, stated that the method adopted for the preparation of the diazobenzene chloride was that described by Dr. Cain in his paper. The solution was raised to the desired temperature in fifteen to thirty seconds.

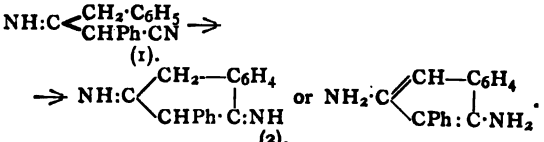
As evidence that supersaturation was really present the author referred to an actual comparison experiment, showing the volume of gas evolved from solutions stirred and not stirred, where it was seen from the lantern-slide exhibited that at one time 37 c.c. of the solution at 62° held supersaturated 22 c.c. of nitrogen, or more than thirty times the amount calculated from the solubility of the gas. The author also gave numbers showing the great difference between his constants for the reaction and those determined by Cain and Nicoll.

A reaction resulting in the evolution of carbon dioxide had been studied, but owing to the greater solubility, the degree of supersaturation was small, and at present the author had not sufficient data to say whether a highly supersaturated solution is more easily formed in the case of the more insoluble gases.

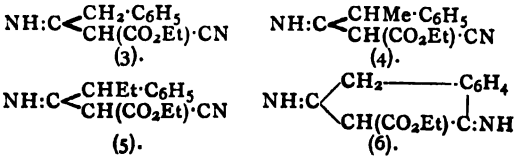
In the comparison experiments on the decomposition of hydrogen peroxide in which the rates of reaction were determined by measurement of the gas evolved from the stirred solution and by titration respectively, in the latter case the solution was *not* stirred, and therefore the close agreement in the results showed that the rate of evolution of gas from the stirred solution also measured truly the rate of reaction in the still liquid. Moreover, if the reaction is allowed to begin without agitation and at a given time the solution is suddenly stirred, an immediate evolution of gas takes place, making the total volume of gas evolved equal to the amount given off in the same time *with* stirring, thus showing that stirring does not influence the rate of the reaction, but simply gives a correct method of measuring it.

*204. "*The Formation and Reactions of Imino-compounds.* Part II. *Condensation of Benzyl Cyanide leading to the Formation of 1 : 3-Diaminonaphthalene and its Derivatives.*" By ERNEST FRANCIS JOSEPH ATKINSON and JOCELYN FIELD THORPE.

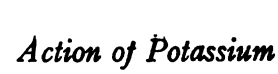
Benzyl cyanide condenses with its sodium derivative to form β-imino-α-cyano-αγ-diphenylpropane (1), which on treatment with sulphuric acid is completely converted into 1 : 3-*diamino-2-phenylnaphthalene* (2),—



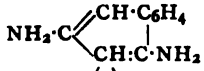
Benzyl cyanide also combines with the sodium derivative of ethyl cyanoacetate, forming ethyl β-imino-α-cyano-γ-phenylbutyrate (3), from which on treatment with sodium ethoxide and either methyl or ethyl iodide, *ethyl β-imino-α-cyano-γγ-phenylmethylbutyrate* (4), or *ethyl β-imino-α-cyano-γγ-phenylethylbutyrate* (5) can be prepared. From these compounds on treatment with sulphuric acid ethyl 1 : 3-diaminonaphthalene-2-carboxylate (6), *ethyl 1 : 3-diamino-4-methylnaphthalene-2-carboxylate* (7), and *ethyl 1 : 3-diamino-4-ethylnaphthalene-2-carboxylate* (8) are formed respectively:—

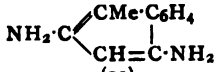


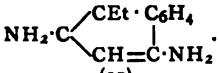
(7).


(8).

The ethyl esters (6), (7), and (8) are converted on hydrolysis into the corresponding *carboxylic acids*, which on heating above their melting-points are transformed into 1 : 3-diaminonaphthalene (9), 1 : 3-*diamino*-4-*methylnaphthalene* (10), and 1 : 3-*diamino*-4-*ethylnaphthalene* (11), respectively:


(9).


(10).


(11).

DISCUSSION.

The PRESIDENT pointed out that the very elegant synthetical method of obtaining 1 : 3-diaminonaphthalene made known by the authors might prove of great practical use in preparing this base in quantity. The method hitherto available, in which dinitro-*a*-acetnaphthalide is the starting-point, is both circuitous and costly.

In reply to a question from Mr. Lees, Dr. THORPE said that only primary nitriles reacted to form the imino-compounds; one of the two nitriles entering into the reaction must contain the group $CH_2 \cdot CN$.

*205. "*Note on the Anhydride of Phenylsuccinic Acid.*" By FRANCIS BERNHARD DEHN and JOCELYN FIELD THORPE.

The authors have investigated the anhydride of phenylsuccinic acid, and conclude that it exists in only one form, which melts at 53—54°. They have been unable to prepare the other form of the anhydride melting at 150° described by Bredt and Kallen, and by Wegscheider and Hecht, but by following the experimental details given by these investigators they have isolated an impure form of the acid which melts at this temperature. The authors have been unable to confirm the observation of Wegscheider and Hecht that the anhydride melting at 53—54° gradually passes into that melting at 150° when kept at the ordinary temperatures and also at 100°. They have kept specimens of the pure anhydride for several months under these conditions, and have observed no change.

*206. "*Influence of Sodium Arsenate on the Fermentation of Glucose by Yeast-juice.*" (Preliminary Notice). By ARTHUR HARDEN and WILLIAM JOHN YOUNG.

It has been previously shown that when a soluble phosphate is added to yeast-juice containing glucose, the rate of fermentation is greatly increased (five to ten times), and proceeds at a gradually diminishing rate until an extra amount of carbon dioxide (equivalent, molecule for molecule, to the phosphate added) has been evolved. The rate then becomes equal to, or somewhat greater than, that of the original juice to which no addition has been made. The phosphate at the same time undergoes a change which renders it non-precipitable by magnesia mixture (*Proc. Roy. Soc.*, 1906, lxxvii., B, 405).

When an equivalent amount of arsenate is substituted for the phosphate a similar acceleration is produced, but the phenomena are somewhat different. The rate is greatly increased (eight to twelve times), but this high rate continues for a considerable time without change, until many times the equivalent of carbon dioxide has been evolved, and then falls gradually, the fermentation ceasing considerably before that of a sample of the same yeast-juice to which no addition of arsenate has been made.

An example is afforded by an experiment with the undermentioned solutions:—

1. Twenty c.c. of yeast-juice + 5 c.c. water + 5 grms. glucose.

2. Twenty c.c. of yeast-juice + 5 c.c. 3M/10 di-sodium hydrogen arsenate + 5 grms. glucose.

The following numbers give the number of c.c. of carbon dioxide evolved during the time given in the first column:—

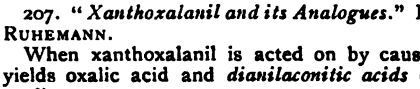
| Time. | C.c. of $CO_2$. Sol. I. | Sol. II. |
|---|---|---|
| 1 hour | 20·9 | 249·8 |
| 2 hours | 41·2 | 491·5 |
| 5 " | 99·5 | 797 |
| 6 " | 118·1 | 831 |
| 7 " | 136·2 | 848·8 |

At the end of seven hours, the rate per hour of Solution 1 was still 18 c.c. per hour, and that of Solution 2 had fallen from 249·8 to 14·8.

The rate attained and the duration of the fermentation vary both with the particular specimen of yeast-juice and with the amount of arsenate added, there being a certain optimum amount of arsenate for each sample of yeast-juice. The added arsenate remains precipitable by magnesia mixture after an equivalent of carbon dioxide has been evolved, and is also still in the same form when the fermentation ceases, so that in this respect it differs from the phosphate.

207. "*Xanthoxalanil and its Analogues.*" By SIEGFRIED RUHEMANN.

When xanthoxalanil is acted on by caustic potash, it yields oxalic acid and *dianilaconitic acids* (m. p. 199—200°):—



$$= (CO_2H)_2 + C_3H_3(CO_2H)(CO \cdot NHPh)_2;$$

the latter of which differs from the compound described by Michael (*Am. Chem. Journ.*, 1887, ix., 193), and, on hydrolysis with hydrochloric acid, furnishes aconitic acid. *Xanthoxalo*-m-*xylidil*, $C_{24}H_{20}O_5N_2$, similarly gives *di*-m-*xylidil aconitic acid*, melting at 196—197° with decomposition. Xanthoxalanil and its analogues are transformed into colourless substances on reduction with zinc dust and acetic acid. The *compound* (m. p. 160—161°) which is thus formed from xanthoxalo-*m*-xylidil, has the formula $C_{24}H_{26}O_5N_2$.

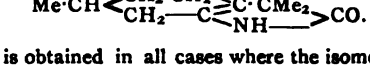
208. "*Derivatives of Cyanodihydrocarvone and Cyanocarvomenthone.*" By ARTHUR LAPWORTH.

Cyanodihydrocarvone (*Trans.*, 1906, lxxxix., 949) yields a *cyanohydrin* which is slowly hydrolysed by mineral acids, being finally transformed into 2-*methyl*-5-iso*propenyl*-$\Delta^3$-*tetrahydro*iso*phthalic acid*. On reduction, the latter yields a mixture of isomeric 2-*methyl*-5-iso*propenylhexahydro*iso*phthalic acids*, which, although still unsaturated, are not further reduced by sodium amalgam.

The addition compounds of cyanodihydrocarvone with hydrogen halides are well characterised substances which yield substitution products with bromine. The *hydriodide* may be reduced by zinc and methyl alcohol to *cyanocarvomenthone*, which may be converted by acids into *carvomethonecarboxylic acid*, and by alkalis into carvotanacetone.

209. "*Reactions involving the Addition of Hydrogen Cyanide to Carbon Compounds.* Part VI. *The Action of Potassium Cyanide on Pulegone.*" By REGINALD WILLIAM LANE CLARKE and ARTHUR LAPWORTH.

The compound $C_{11}H_{17}ON$, obtained by the action of potassium cyanide on pulegone, is easily converted into *menthonecarboxylic acid* (compare Hann and Lapworth, *Proc.*, 1904, xx., 54). The latter may be transformed into an unsaturated *lactone*, $C_{11}H_{16}O_2$, and from this, ammonia regenerates the initial substance $C_{11}H_{17}ON$, which is therefore not cyanomenthone, as was for a long time supposed, but the *anhydramide*,—



This is obtained in all cases where the isomeric cyanomenthone would be the normal product.

210. "*The Influence of various Substituents on the Optical Activity of Tartramide.*" (Part II.). By PERCY FARADAY FRANKLAND and DOUGLAS FRANK TWISS.

In continuation of the previous work of P. F. Frankland and Slator (*Trans.*, 1903, lxxxiii., 1349), the authors have prepared and described the n- and iso*propylamides* the *allylamide*, the n- and iso*butylamides*, and the n-*heptylamide* of tartaric acid. The rotation of these compounds has been determined in pyridine, in methyl alcohol, and, when possible, also in aqueous solutions.

All the aliphatic amides have much lower molecular rotations than the aromatic amides. In the fatty amides of the normal series, the molecular rotation increases without exhibiting a maximum up to the heptyl term, which is as far as the series has yet been explored. The rotation of the benzylamide and furfurylamide follows closely on that of the heptylamide, there being a large gap between these and the true aromatic amides.

Special interest attaches to the lower rotation found for the allylamide than for the normal propylamide, as in general the appearance of a double bond in a compound is attended with a marked increase in the rotation.

211. "*The Influence of various Substituents on the Optical Activity of Malamide.*" By PERCY FARADAY FRANKLAND and EDWARD DONE.

The authors described the preparation and properties of the *methylamide*, *ethylamide*, and iso*propylamide*, *allylamide*, and iso*butylamide*, n-*heptylamide*, *piperidide*, and *phenylhydrazide* of ordinary *l*-malic acid. The rotation was determined in pyridine, in methyl alcohol, and in glacial acetic acid solution.

The rotation is greatly influenced by the solvent. In pyridine solution, the amides of the normal series exhibit practically no change in molecular rotation from the methyl to the heptyl term. In methyl alcohol solution, on the other hand, there is a slight rise in the value of $[M]_D$ between the methyl and heptyl terms, whilst in glacial acetic acid solution there is a slight decline over the same interval.

The allylamide has a markedly lower rotation than the normal propylamide.

The piperidide and phenylhydrazide have much lower rotations than any of the aliphatic amides; in fact, even lower than than that of malamide itself.

*Research Fund.*

A meeting of the Research Fund Committee will be held in December. Applications for grants, to be made on forms which can be obtained from the Assistant Secretary, must be received on, or before, Monday, December 10th next.

ERRATA.—P. 227, col. 2, line 9 from bottom and in following cases, for "xanthydryl" read "xanthyl. P. 250, col. 2, lines 16 and 30, for "3-carboxylic" read "4-carboxylic."

**Chromium Dioxide and the Constitution of Chromic Acid.**—W. Manchot and R. Kraus.—The authors have prepared chromium dioxide by oxidising chromium oxide with gaseous oxygen. They obtained the former by precipitating the hydroxide with ammonia from chrome alum or chromium sulphate solution, and heating it in a test-tube until it suddenly glowed, and gave on cooling the green oxide. This was then heated to 240° and oxygen was passed over it for three or four hours. The dioxide was then cooled and decomposed again by heating, the oxygen being collected. The peroxide is a light very hygroscopic black powder; it gives up oxygen at a faint red heat, leaving the green oxide; with hydrochloric acid it gives off chlorine slowly, and it is gradually reduced by hydriodic acid. When pure it gives no chromic acid with cold water, but chromates are formed when it is warmed with alkalis. Probably it is a derivative of tetravalent chromium, O : Cr : O.—*Berichte*, xxxix., No. 13.

## NOTICES OF BOOKS.

*Paper Technology*: an Elementary Manual on the Manufacture, Physical Qualities, and Chemical Constituents of Paper and of Paper-making Fibres. By R. W. SINDALL. London: Griffin and Co., Ltd. 1906.

THE author's perspective is set forth in the title and subtitle of this book, which are properly descriptive of its contents. The matter of the work being the substance of a course of lectures delivered in 1904-5, is, necessarily, in large part a compilation, but the original impress of the worker and master of the subject is uppermost throughout. As the title indicates, it is a treatise on Paper from the point of view of the user—and therefore buyer,—and the processes of manufacture are described only so far as it is necessary for the buyer to appreciate the dependence of quality upon the raw materials employed and the treatment by which they are converted into paper. Special chapters are devoted to Rag Papers, Esparto and Straw, Wood-pulp and Wood-pulp Papers, Packing and "Art" Papers, and they contain, not merely "stock" information, but a number of original observations which add considerably to the interest of these sections. Particularly we notice the critical discussion of the qualities and defects of the so-called "art" papers, excellently pointed by illustrations and by suggestions of the lines of investigation along which an ideal printing surface may be sought without sacrificing those qualities which condition permanence.

The sections devoted to the physical, mechanical, and chemical tests of the "expert" are very well handled, and the author's original grasp is evidenced by the inclusion of results of investigations which bring out the variation of the mechanical and physical constants of a given paper through the various stages of making, sizing, and finishing. The young student and the "practical" man will find that trouble has been taken to state the matter of this section in the clearest language; it is rounded off by a dictionary and glossary of terms used in the mill, the laboratory, and the trade.

The book commends itself by its title to a very wide circle of readers, and our judgment is that every section of workers in the industry of Paper will find that the author has identified himself by practical experience with their special needs and points of view, and they will derive both pleasure and profit from acquainting themselves with the results of this experience.

*A History of Chemistry*. By ERNST VON MEYER, Ph.D. Translated with the Author's Sanction by GEORGE MCGOWAN, Ph.D. Third English Edition. London: Macmillan and Co., Ltd. New York: The Macmillan Company. 1906.

WHEN this History of Chemistry was first translated into English fifteen years ago, it was practically the only book of its scope which was at the disposal of English-speaking students; and now, although that state of affairs has been remedied, and the chemist has a choice both of complete histories of the science and also of monographs on special branches and periods, Prof. Ernst Meyer's History will still retain its place. The third English edition has been prepared from the third German edition, with various additions and alterations made by the translator with the author's sanction. The new matter which has been added deals chiefly with physical chemistry, the section on which has been much enlarged, as have also the chapters on agricultural and physiological chemistry, while there is an interesting section on the growth of chemical instruction, with special reference to Germany. Throughout the book there are also fresh biographical notices, and the record is brought down to the most recent date possible. The importance of the possession of a knowledge of the development of a science in order properly to appreciate its present standpoint is being constantly

more fully recognised, and an authoritative work such as this has a special value both for students and teachers.

---

*Service Chemistry*. By Vivian B. Lewes, F.I.C., F.C.S. and J. S. S. Brame, F.C.S. Third Edition. London Henry Glaisher. Greenwich: James Glaisher. 1906.

This manual of chemistry, which is intended more especially for the use of officers of the naval and military services, gives special prominence to such subjects as are likely to be of importance to its readers, and at the same time condenses, as far as possible, theoretical considerations. Thus the chemistry of fuels and explosives is discussed at greater length than is usual in a text-book of the size, and throughout the reader will find that he is specialising as far as is advisable; this does not, however, mean that general principles are neglected, but that practical applications are considered rather from a special than a general point of view, and there can be no doubt that this method of presenting the subject will be of great assistance to those for whom the book is intended. For the third edition the text has been carefully revised and extensive alterations made, so much so that the book has almost been re-written.

---

*Manual of Chemistry*. By W. Simon, Ph.D., M.D. Eighth Edition. London: Baillière, Tindall, and Cox. 1906.

The chapters on organic chemistry in this manual for the use of students of medicine, pharmacy, and dentistry have been entirely re-written, while additional space is given to dental metallurgy, and the whole of the text has been brought up to date. In its present form the book is a useful guide for dental and medical students, both as a text-book to supplement their lecture courses, as a work of reference, and for laboratory work, including both preparations and analysis. The valuable plates showing the colours of precipitates, indicators, &c., will be found useful as standards of comparison, and the copious lists of questions, if properly used, should help to fix the student's knowledge. Physiological chemistry is well treated, and the section on organic chemistry also gives a clear review of the essentials of the subject.

---

*Die Untersuchung des Erdöles und seiner Produkte*. ("The Examination of Petroleum and its Products"). By M. A. Rakusin. Braunschweig: Friedrich Vieweg und Sohn. 1906.

This book discusses practical methods of testing naphtha, with special reference to the recommendations of the Baku and St. Petersburg Commissions for the establishment of standards for the testing of naphtha products. It aims at giving a complete account of the physico-chemical methods of examining mineral oils as far as they are of scientific or practical interest, while synthetic methods of preparation and the geological aspect of the subject are not touched upon. Much of the author's own work is described in the text—not, however, to the exclusion of that of other investigators. Many tables of interest in the testing of mineral oils are included—such as, for example, those of the specific gravities of kerosene and naphtha residues at different temperatures, and full practical descriptions of the necessary experimental work are given. The various methods of storing mineral oils are illustrated and discussed. The weighing of liquids in stationary holders by means of the pneumatic reservoir balance of Sacharoff is considered at length, its possible technical importance being fully recognised. The author has been at pains to overlook no question which comes within his province, and the outcome of his labours is a complete and comprehensive account of scientific and technical methods of testing naphtha products.

# CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

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*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*. Vol. cxliii., No. 19, November 5, 1906.

**Alcoholysis of Fatty Bodies.**—A. Haller.—The author's researches prove—(1) That all the glycerides can be subjected to alcoholysis, and that those of low molecular weight are more easily decomposed than the higher glycerides; (2) that all the fatty bodies soluble in alcohol alcoholyse more easily than those which are insoluble; (3) that alcoholysis is facilitated when the operation takes place in the medium of a solvent of the fatty body; (4) that the transformation of fatty matters into glycerin and ether salts constitutes a very practical method for the preparation of a certain number of these ethers and also a new method of qualitative analysis of the same substances; (5) that the operation of alcoholysis takes place at a relatively high temperature, and in presence of a little acid allows certain bodies which are only present in natural products in minute quantities to be recognised by their perfume.

**Conditions of Precipitation and Re-dissolving of Metallic Sulphides.**—H. Baubigny.—The author performs a series of experiments on the subject of the precipitation and re-dissolving of a number of metallic sulphides, and finds that his conclusions are identical with those of MM. Bruni and Padva.

**Gases evolved during the Action of Potash on Tantalite.**—C. Chabrié and F. Levallois.—When tantalite is heated alone a slight evolution of gas takes place, the composition being—$CO_2$, 84 per cent; N, 12·4 per cent; O, 3·1 per cent; but when it is fused with four times its weight of potash *in vacuo* a copious evolution of gas takes place, the composition in this case being—H, 93·2 per cent; N, 4·6 per cent; and O, 1·2 per cent. Both substances are chemically pure. The authors explain this reaction as follows:—It must be admitted that the potash is substituted for the protoxide of iron in the mineral; then that this iron protoxide reduces the potassium hydrate, giving water, hydrogen, and sesquioxide of iron: $2Ta_2O.FeO + 4KOH = 4TaO_3K + Fe_2O_3 + H_2O + H_2$.

**Selenium.**—Œchsner de Coninck.—The selenium which is prepared from the sulphoxide appears to be of a stable variety, and it is interesting to note that the selenium which enters into the compound $SeSO_3$ in a certain physical form can be taken away from this compound in a totally different form.

**Chloruration of Paraldehyde and Butyric Chloral.**—P. Freundler.—The author investigates the difference between the action of bromine and chlorine on paraldehyde. He finds that the chloruration can only be effected at ordinary temperatures and under the conditions in which acetic aldehyde and chloracetic aldehyde are condensed under the influence of hydrochloric acid to form α-chlorocrotonic aldehyde. On the contrary, the bromuration of paraldehyde takes place almost integrally at 0°, *i.e.*, at a temperature below that of crotonisation:—

$$CH_2Br.CHO + CH_2Br.CHO = CH_2Br.CH{=}CBrCHO + H_2O$$

$$CH_2BrCH{=}CBrCHO + Br_2 = CH_2Br.CHBr.CBr_2.CHO.$$

Chloral and bromal appear to be able to be acetalised in the same way as butyric chloral. These various acetals, the author hopes, will enable him to effect some interesting syntheses.

**Phenylic Migration.**—M. Tiffeneau.

**Constitutional Formula of certain Dimethylanthracenes.**—James Lavaux.—In order to control certain deductions regarding the constitutional formula of dimethylanthracenes, the author oxidises β-dimethylanthracene, first to dimethylanthraquinone, then to methylanthraquinone carbonic acid, which by means of zinc and ammonia he reduces into methylanthracene carbonic acid, and finally, after distillation with soda-lime, obtains β-methylanthracene. This and another experiment described in detail are enough to establish the constitution of the bodies.

## MISCELLANEOUS.

**Dimethylglyoxim: a New Reagent for Nickel.**—α-Dimethyglyoxim (see C. Schramm, *Ber.*, 1883, p. 180), $CH_3C{\cdot}(:N{\cdot}OH)C(:N{\cdot}OH){\cdot}CH_3$, forms white crystals melting at 240° C. sparingly soluble in water, but dissolving freely in alcohol and ether. L. Tschugaeff (*Ber.*, 1905, p. 2520) discovered accidentally whilst investigating the properties of some complex substances that dimethylglyoxim is an extremely sensitive reagent with respect to nickel. The solution to be tested is mixed with ammonia or sodium acetate in excess, a little powdered dimethylglyoxim is then added, and the mixture made to boil. In the presence of nickel a beautiful scarlet-red precipitate forms either at once or when the solution has cooled, according to the proportion of nickel present. The dioxim which separates out during the process of cooling acquires likewise a distinct pink tint through the influence of the nickel. The reagent is, according to E. Tschugaeff, sensitive enough to indicate the presence of 1 part of nickel in 400,000 parts of water. When the simultaneous presence of cobalt is suspected, especially when it is required to test salts of cobalt for absence of nickel, the method has to be applied in a slightly modified form, since cobalt forms a brown compound with the reagent. In this case the test solution should be shaken up repeatedly with a large excess of ammonia, which gives rise to the formation of complex cobaltamines, and the resulting solution should be tested for nickel. On filtering the solution after the addition of the reagent the red nickel compound remains upon the filter, after drying it dissolves in a hot mixture of chloroform and alcohol, and after the evaporation of the solvent remains in the form of microcrystalline spiculæ. It is claimed that nickel may thus be distinguished in the presence of 5000 times the quantity of cobalt.—*Merck's Annual Report*, for 1905.

## MEETINGS FOR THE WEEK.

MONDAY, Dec. 3rd.—Royal Institution, 5. General Monthly Meeting.
— Society of Arts, 8. (Cantor Lectures). "Artificial Fertilisers—their Nature and Functions," by A. D. Hall.
— Society of Chemical Industry, 8 "Direct Estimation of Antimony," by H. W. Rowell. "Bacterial. Method of Investigating Disinfectants," by M. Wynter Blyth. "Detannisation of Solutions in the Analysis of Tanning Materials," by J. G. Parker and H. G. Bennett.

TUESDAY, 4th.—Society of Arts, 4.30. "The Cape to Cairo Railway," by The Hon. Sir Lewis Lloyd Michell.

WEDNESDAY, 5th.—Society of Arts, 8. "The Metric System," by Col Sir Charles M. Watson, K.C.M.G., &c.
— Society of Public Analysts, 8. "Amount of Calcium Oxalate in the Ash of Cinnamon and Cassia Barks," by J. Hendrick. "Estimation of Preservatives in Milk," by H. S Shrewsbury. "Fractional Distillation by Steam Vapour," by H. Hardy and B. Richens. "Estimation of Mineral Acid in Vinegar," by P. Schidrowitz.

THURSDAY, 6th —Chemical, 8 30. "Liquid Volume of a Dissolved Substance," by J. S. Lumsden. "Some Derivatives of Benzophenone—Synthesis of Substances occurring in Coco-bark," by W. H. Perkin, jun., and R Robinson. "Synthesis of Terebic, Terpenylic, and Homoterpenylic Acids," by J. L. Simonsen.

## NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertisement columns.

**Methyl Butadiene.**—Can any reader give particulars of the synthesis of methyl butadiene, $CH_2{:}CMe.CH{:}CH_2$?—M. H.

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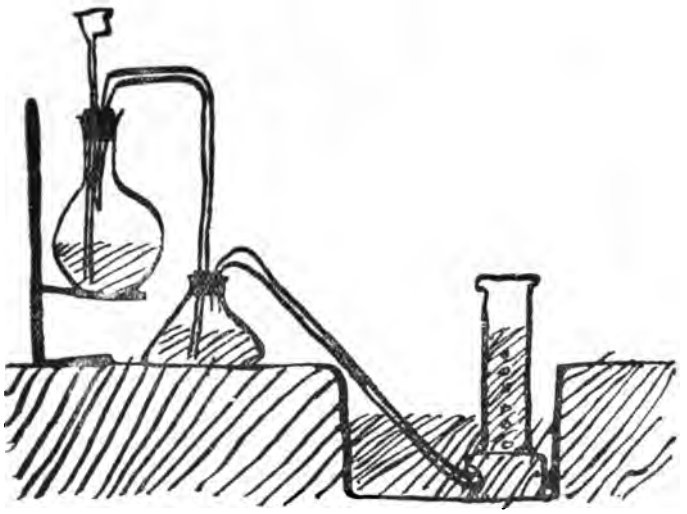

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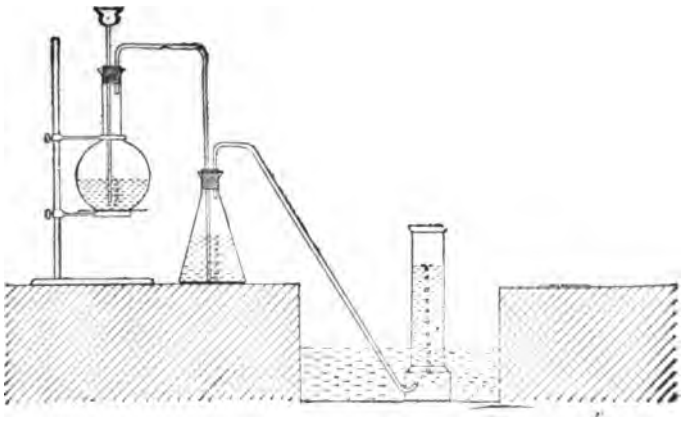

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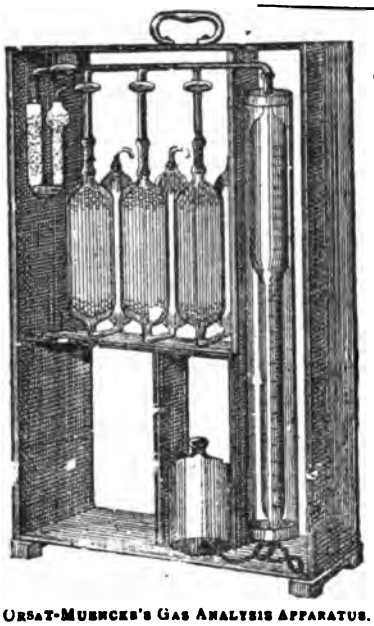

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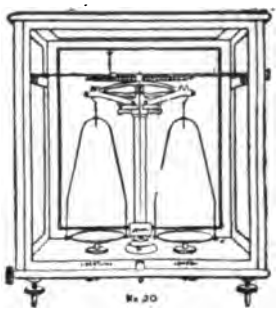

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Vol. XCIV., No. 2454.

## ISOMORPHOUS CRYSTALS OF THE NITRATES OF BARIUM AND LEAD.

By P. GAUBERT.

A crystal in the course of growth can sometimes be coupled with a greater or smaller amount of another crystalline substance in solution in its mother-liquor, and, if this is a colouring matter, the faces belonging to the different forms do not always have the same coefficient of absorption. Hydrated phthalic acid, coloured by the aniline dyes, furnishes an excellent example of this property.

I have been led to enquire whether a phenomenon of the same nature is not produced in isomorphous mixtures. To this end I have experimented on the nitrates of barium and of lead, the mixed crystals of which have been the object of many discussions from other points of view.

It is known that these two substances, dissolved individually or together, always give by cooling a pure boiling solution, octahedra, and by slow evaporation at the ordinary temperature, especially if the solution be acidified with nitric acid, cubic octahedra with several other slightly developed faces, in particular the pentagonal dodecahedral.

I have before demonstrated that the crystals of these nitrates, and above all those of lead nitrate, crystallising in a mother-liquor containing methylene blue, absorb far more of the colouring matter by the cubic faces than by the other faces, and it is this fact that led me to experiment on the cubic nitrates amongst the isomorphous bodies. I sought to determine if the octahedral faces and the cubic faces of the crystals of barium nitrate absorb the same quantity of lead nitrate, dissolved in small quantity in the mother-liquor, and reciprocally.

In one series of experiments 500 grms. of barium nitrate, and 10 grms. of lead nitrate were dissolved, each time in water, and the solution saturated at the ordinary temperature was slowly evaporated at 18° to 25°. When a sufficient quantity of crystals had been deposited, a grm. of the substance was detached from the pyramids corresponding to the octahedral faces, and another grm. from those of the cubic formation.

This preparation obviously demands much care and patience. The estimation of the lead by a colorimetric method shows that the amounts of the crystals with octahedral faces contain more lead than the cubic crystals. The determinations were repeated several times, and the results were always in agreement.

The ratios of the quantities of lead were found approximately equal to 4 : 3, 5 : 3, 5 : 4, 9 : 8. They differed a little among themselves, the quantities of lead nitrate crystallising with barium nitrate varying with the temperature, and their estimation being difficult, but they indicated sufficiently well the nature of the phenomenon.

I took the precaution of using transparent crystals to eliminate the error due to inclusions of the mother-liquor upon the two classes of crystals.

Similar estimations were made with crystals of lead nitrate obtained by slow evaporation of a solution containing a small quantity of baryta and of nitric acid. It was still the octahedral faces which absorbed more of the barium nitrate than the cubic.

These results explain the complexity of the optical properties of the cubic nitrates. In the crystals of lead nitrate containing a small quantity of barium nitrate, the axes corresponding to each class of face have a particular double refraction (F. Klocke, R. Brauns, J. Morel, &c,) The pyramids with the octahedral faces are much more doubly refracting than the cubic, often singly refracting, and less so than those of the pentagonal dodecahedral formation; it is also known that the double refraction increases with the amount of barium nitrate contained in the crystal. Consequently, my experiments show that if the various axes have not the same double refraction, it is because they have not the same chemical composition.

To sum up, a crystal of lead nitrate containing barium nitrate, and *vice versa*, is not homogeneous, in spite of its transparency and clearness; it is built up by the grouping of pyramids of which the composition varies with the nature of the faces to which they correspond. The same structure is observed in certain minerals of the volcanic rocks, in explanation of which numerous theories have been advanced. My experiments show that this structure should be considered as the primary cause; it is fixed before the first appearing of the crystallisation.—*Comptes Rendus*, cxliii., No. 21, p. 776.

## CONTRIBUTION TO THE STUDY OF PER-SALTS.*

By Prof. E. PINERUA ALVAREZ.

The per-salts obtained and studied by us are the pernitrates, perphosphates, perarseniates, pertungstates, perphosphotungstates. They are all derived from the corresponding peroxidised acids, in which part of the oxygen is loosely combined with the rest of the molecule, a slight elevation of temperature or the action of acidified water being sufficient to decompose these salts, setting free all the oxygen which we can call displaceable, and which unites with the water, if the temperature is low, to produce hydrogen peroxide; hence these are hydroperoxylic salts.

They are all easily obtained by the action of sodium dioxide on the alkaline salts of nitric, phosphoric, arsenic, tungstic, and phosphotungstic acids.

We obtained the pernitrate by dissolving 100 grms. of nitre in a mixture of 2000 grms. of water and 1800 or alcohol at 98°, then cooling the vessel containing the solution with ice and salt; finally, 160 grms. sodium dioxide is added by degrees, part of the salt produced is precipitated by the action of 1800 grms. absolute alcohol, the liquid is rapidly filtered on the pump, carefully washed with anhydrous alcohol, the product recovered from the filter, and finally dried in the vacuum and in presence of phosphorus anhydride.

The filtered liquids on evaporation give the greater part of the salt.

The method of procedure followed by us in order to obtain the other per-salts is exactly the same.

The quantities of the substances used are as follows:—

| | Grms. |
|---|---|
| Sodium perphosphate— | |
| Di-sodium phosphate | 50 |
| Alcohol | 3000 |
| Water | 3000 |
| Sodium dioxide | 70 |
| Sodium perarsenate— | |
| Di-sodium arseniate | 50 |
| Water | 2000 |
| Alcohol | 2000 |
| Sodium dioxide | 100 |
| Sodium pertungstate— | |
| Sodium tungstate | 50 |
| Alcohol | 1000 |
| Water | 1000 |
| Sodium dioxide | 90 |

* Note presented at the Sixth International Congress of Applied Chemistry, held at Rome, 1906.

Sodium phosphopertungstate—

| | |
|---|---|
| Phosphotungstic acid .. .. .. | 20 |
| Water .. .. .. .. .. .. | 750 |
| Alcohol .. .. .. .. .. .. | 750 |
| Sodium dioxide .. .. .. .. | 80 |

In each case the precipitation was effected with anhydrous ethyl alcohol, and the precipitate washed and dried as already described. The filtration liquids by spontaneous evaporation gave us the greater part of the crystallised salts.

The reactions of formation are as follows :—

$$KNO_3 + Na_2O_2 + H_2O = KNO_4 + 2NaOH;$$
Potassium nitrate. Potassium pernitrate.

$$Na_2HPO_4 + Na_2O_2 + H_2O = NaPO_4 + 3NaOH;$$
Disodium phosphate. Sodium perphosphate.

$$Na_2HAsO_4 + Na_2O_2 + H_2O = NaAsO_4 + 3NaOH;$$
Disodium arseniate. Sodium perarseniate.

$$2Na_2WO_4 + Na_2O_2 + 2H_2O = 2NaWO_4 + 4NaOH;$$
Normal sodium tungstate. Sodium pertungstate.

The reactions of decomposition by water are :—

$$KNO_4 + H_2O = KNO_3 + H_2O + O;$$
Potassium pernitrate. Potassium nitrate.

$$NaPO_4 + 2H_2O = NaH_2PO_4 + H_2O + O;$$
Sodium perphosphate. Disodium phosphate.

$$NaAsO_4 + 2H_2O = NaH_2AsO_4 + H_2O + O;$$
Sodium perarseniate. Disodium arseniate.

$$2NaWO_4 + 2H_2O = Na_2W_2O_4 + H_2O + O;$$
Sodium pertungstate. Sodium ditungstate.

The quantities of oxygen determined by experiment represent the former equalities.

If the water be strongly acidified, we find in the second members of these equations the corresponding sodium bisulphate, and free nitric, phosphoric, arsenic, and tungstic acids.

All the alkaline per-salts quoted are solids, and of a white colour. They occur also in amorphous and crystalline forms.

The amorphous varieties, obtained by precipitation with alcohol, contained varying quantities of the hydrate of sodium dioxide, which almost completely veil the true chemical properties of these per-salts.

I have even observed this in many specimens of commercial amorphous perborates, which have a strongly alkaline reaction, due principally to the hydrate of the dioxides, which makes them caustic and unsuitable for use in medicine.

On the other hand, the crystallised salts, after being carefully washed and dried *in vacuo*, are neutral, and their chemical reactions are very different from those of the amorphous varieties.

We will consider here the chief chemical properties of the per-salts quoted, and those of the hydrate of the dioxide, in order to compare them with those exhibited by the amorphous.

I. With lead acetate all the crystallised per-salts give a white precipitate of the lead per-salt, soluble in nitric acid with brisk effervescence.

The amorphous per-salts give a red precipitate of sodium and lead orthoplumbate, which with nitric acid gives a residue of $PbO_2$.

The hydrate of the dioxide gives the same red precipitate.

II. With silver nitrate all the crystallised per-salts give a white precipitate, but the silver compounds of these peroxidised acids are so unstable that after a short time they turn grey or yellow, with liberation of oxygen.

The amorphous per-salts all produce with this reagent a grey or black precipitate, which is a mixture of silver and the peroxide of the same metal.

The hydrate of the peroxide reacts similarly to the amorphous salts.

III. With mercurous nitrate the white precipitate formed by the crystallised per-salts decomposes very rapidly, and becomes blackish grey or brown (perphosphate).

The amorphous per-salts, like the hydrate of sodium dioxide, NaO.OH, give immediately a black precipitate.

IV. With mercuric chloride all the crystallised per-salts form a very intense red precipitate, soluble with effervescence in hydrochloric acid.

The amorphous per-salts produce with mercuric chloride a yellow-red precipitate like that of the hydrate of sodium peroxide.

V. With copper sulphate the crystallised per-salts give a blue precipitate of the cupric per-salt.

The amorphous per-salts give with it a yellow-green basic salt, and with a great excess of per-salt and heat it becomes black.

VI. With the sulphates of zinc and cadmium both the crystallised and amorphous per-salts give a white precipitate.

VII. With a solution of bismuth nitrate neutralised to cloudiness, the crystallised per-salts give a white crystalline precipitate.

The amorphous per-salts give rise to a yellow-red precipitate, which is the hydrate of bismuth dioxide, $BiO(OH)_2$. This last reaction is identical with that of the hydrate of sodium dioxide with the same bismuthic salt.

VIII. With gold chloride the crystallised per-salts produce only a slight effervescence, due to the oxygen set free by hydrolysis of the per-salt.

The amorphous per-salts give rise first to a blue liquid due to the reduction of the auric hydrate to aurous, and then a precipitate of metallic gold.

The hydrate of the dioxide gives rise to the auric hydrate, which hydrogen peroxide reduces to the aurous hydrate (blue), and finally to metallic gold.

IX. With manganous chloride and sulphate, the crystallised per-salts give a very stable pink precipitate of the manganous per-salt, soluble with effervescence in hydrochloric acid.

The amorphous variety produces a purple or brown deposit of manganic hydrate.

The hydrate of the dioxide produces the same reaction.

X. With the sulphate and chloride of nickel the crystallised per-salts give a whitish green precipitate of the nickel per-salt. The amorphous salts give a precipitate of the basic salt, like the hydrate of sodium dioxide.

XI. With cobaltous nitrate and chloride the crystallised per-salts give precipitates of a beautiful pink colour, which are the cobaltous per-salts.

The amorphous per-salts produce first a yellowish green precipitate, which finally becomes the deep brown of cobaltic hydrate. The hydrate of sodium dioxide produces the latter reaction.

XII. With ferrous sulphate all the crystallised per-salts give a green or blue-green precipitate, which with the pernitrate becomes so intense that it appears black.

The amorphous salts form, like the hydrate of the dioxide, a red precipitate of ferric hydrate.

XIII. With ferric chloride the crystallised per-salts, as well as the amorphous, give a red precipitate of ferric hydrate.

XIV. With the chlorides of calcium, barium, and strontium, all the crystallised per-salts give a white crystalline precipitate of the calcium, barium, and strontium per-salts.

XV. The crystallised per-salts added to a solution of potassium iodide, to which a few drops of sulphuric acid are then added, set free the iodine, and the liquid becomes yellowish red.

The amorphous per-salts, as well as the hydrate of sodium dioxide, present the same phenomenon, but with greater intensity.

The pernitrates with ferrous sulphate and sulphuric acid produce a brisk effervescence due to evolution of oxygen, and assume the characteristic colour of the nitrates.

The perphosphates and perarseniates give precipitates with the magnesium and molybdate mixture.

Finally, if to 0·5 grm. of sodium pertungstate or phosphopertungstate 10 c.c. distilled water be added, and 5 c.c. hydrochloric acid, an abundant evolution of oxygen is at once manifested. On boiling the mixture in a little glass vessel an abundant yellow precipitate of metatungstic acid is preceived after some time, and if stannous chloride be then added the liquid acquires a blue colour, and the blue oxide of tungsten is precipitated.

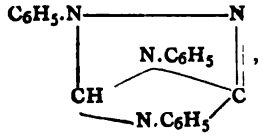
It is obvious that these salts might play an important part in medicine, in the arts and industries, and in chemical analysis, &c.

The pernitrates, for example, which give through the action of heat from 15 to 16 per cent of oxygen, in addition to what they yield as nitrates, are very readily ignited, and therefore of service in the manufacture of explosives.

The perphosphates, which liberate by the action of water from 13 to 14 per cent of oxygen, can be of signal use in medicine.

## NITRON: A NEW REAGENT FOR NITRIC ACID.

NITRON, or 1·4-diphenyl-3·5-endanilo-dihydro-triazol,—



is a base consisting of lustrous yellow leaves or an amorphous powder. The preparation fuses and decomposes at 189° C.; it dissolves in alcohol, benzol, chloroform, acetone, and acetic ether, with difficulty in ether, but is insoluble in water. The nitrate of this base $C_{20}H_{16}N_4$—$HNO_3$. being likewise difficultly soluble in water (at 0° C. to the extent of 1 : 80,000, at ordinary temperature to the extent of 1 : 60000), has suggested itself to M. Busch (*Ber.*, 1905, p. 861), as a practical medium for the identification and quantitative determination of nitric acid and nitrates. According to the investigations of A. Gutbier (*Zeit. Angewandte Chemie*, 1905, No. 13, p. 494), the difficulty with which the salt dissolves is likewise of special value as a means of qualitatively demonstrating in water the presence of nitrates, which may also be determined quantitatively with sufficient accuracy by means of nitron. The reagent consists of a solution of 10 grms. of nitron in 90 grms. of 5 per cent acetic acid. The addition to this of a neutral solution of nitrates or one feebly acidulated with sulphuric acid, either immediately gives rise to a white crystalline precipitate of nitron nitrate depending in quantity upon that of nitrates present, or the nitron nitrate crystallises out quantitatively in the course of a few hours. After washing with a small quantity of cold water the nitron nitrate may be weighed upon a weighed filter or in a Neubauer crucible.

The quantitative analysis is carried out in the following manner:—

Dissolve the substance containing about 0·1 grm. of nitric acid in 80 to 100 c.c. water, add 10 drops of dilute sulphuric acid, heat till near boiling point, and add 10 to 12 c.c. nitron acetate solution. Stand the vessel for one and a-half to two hours in ice water, separate the resulting precipitate by aspiration in a Neubauer crucible, rinsing with the filtrate, and having carried the separation as far as possible, wash with 10 to 12 c.c. ice water. The washing water is added in small portions, time being allowed each time for its complete aspiration. Dry the precipitate at 110° C., when the point of constancy of weight will be found to be attained in three-quarters of an hour.

The calculation conforms to the formula $C_{20}H_{16}N_4.HNO_3$, *i.e.* the resulting weight of nitron nitrate $W \times \frac{63}{315}$ is a measure of the quantity of nitric acid present. The high molecular weight of nitron nitrate endows the method with a special advantage, since any differences of observation which may present themselves become reduced to one-sixth in the evaluation of the nitric acid.—*Merck's Annual Report* for 1905.

## A REVISION OF THE ATOMIC WEIGHT OF BROMINE.*

By GREGORY PAUL BAXTER.

(Concluded from p. 262).

### *The Ratio of Silver Bromide to Silver Chloride.*

THE ratio of silver bromide to silver chloride was determined much as described in previous papers upon the atomic weight of iodine (Baxter, *Proc. Am. Acad. Arts Sci.*, 1904, xl., 432, and 1905, xli., 75; *Journ. Am. Chem. Soc.*, 1905, xxvii., 876). Pure silver bromide was prepared by precipitation of silver nitrate with an excess of ammonium bromide. The silver employed was purified either by precipitation as chloride and reduction with invert sugar, or by electrolysis, or by precipitation with ammonium formate. The metal was then fused before a blowpipe upon a crucible of the purest lime, and the buttons were thoroughly cleansed with nitric acid. No further purification was considered necessary, since the weight of the metal was of no consequence.

After the silver bromide had been washed by decantation with water, in some cases it was collected in a Gooch crucible in which a disk of filter-paper was employed instead of asbestos, and after drying at 100° it was carefully separated from the filter-paper. In other cases the precipitate was transferred to a platinum dish, and was drained with a platinum reverse filter with a disk of filter-paper (Cooke, *Proc. Am. Acad. Arts Sci.*, xii., 121). In still others a platinum Gooch crucible with small holes was found to be sufficiently effective as a filtering medium without the use of either asbestos or filter-paper.

Before being weighed the silver bromide was fused in a current of air saturated with bromine in a weighed quartz crucible. The air was purified by passing successively over beads moistened with silver nitrate solution, over sodium carbonate, and finally over concentrated sulphuric acid which had been heated to its boiling-point with a small quantity of re-crystallised potassium dichromate to eliminate volatile and oxidisable impurities. The air was then passed through dry bromine in a small bulb. This apparatus was constructed entirely of glass with ground joints. The tube which conducted the gases into the crucible passed through a Rose crucible cover of glazed porcelain in all experiments except Analysis 28 to 31, in which a quartz cover was employed. The quartz crucibles were always contained in large porcelain crucibles while being heated. They remained almost absolutely constant in weight during the experiments. The bromine was in each case a portion of the sample from which the silver bromide had been made.

Next the bromide was heated barely to fusion in a slow current of chlorine, generated by the action of hydrochloric

* From the *Journal of the American Chemical Society*, xxviii., No. 10.

TABLE I.—THE ATOMIC WEIGHT OF BROMINE (SERIES I.).
(Ag : AgBr. Ag = 107·930).

| No. of analysis. | Sample of silver. | Sample of bromide. | Weight of silver in vacuum (grms.). | Weight of silver bromide in vacuum (grms.). | Loss on fusion in bromine (grm.). | Weight of asbestos (grm.). | Dissolved silver bromide (grm.). | Corrected weight of silver bromide (grms.). | Ratio Ag : AgBr. | Atomic weight of bromine. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | A | II. | 4·71853 | 8·21362 | 0·00027 | 0·00007 | 0·00021 | 8·21363 | 57·4476 | 79·946 |
| 2. | B | II. | 5·01725 | 8·73387 | 0·00020 | 0·00019 | 0·00007 | 8·73393 | 57·4455 | 79·952 |
| 3. | A | II. | 5·96818 | 10·38799 | 0·00023 | 0·00034 | 0·00122 | 10·38932 | 57·4453 | 79·953 |
| 4. | C | II. | 5·62992 | 9·80000 | 0·00017 | 0·00039 | 0·00017 | 9·80039 | 57·4459 | 79·951 |
| | | | | | | Average .. .. .. .. .. .. .. | | | 57·4461 | 79·950 |
| 5. | A | IV. | 8·13612 | 14·16265 | 0·00002 | 0·00047 | 0·00024 | 14·16334 | 57·4449 | 79·954 |
| 6. | C | IV. | 5·07238 | 8·82932 | 0·00013 | 0·00043 | 0·00035 | 8·82997 | 57·4451 | 79·954 |
| 7. | B | IV. | 4·80711 | 8·36838 | 0·00015(*a*) | 0·00000 | 0·00004 | 8·36827 | 57·4445 | 79·956 |
| | | | | | | Average .. .. .. .. .. .. .. | | | 57·4448 | 79·955 |
| 8. | C | V. | 4·27279 | 7·43771 | 0·00010(*a*) | 0·00009 | 0·00007 | 7·43776 | 57·4473 | 79·947 |
| 9. | A | V. | 5·86115 | 10·20299 | 0·00007(*a*) | 0·00004 | 0·00003 | 10·20299 | 57·4454 | 79·953 |
| 10. | B | V. | 7·91425 | 13·77735 | 0·00010 | 0·00010 | 0·00001 | 13·77736 | 57·4439 | 79·958 |
| 11. | D | V. | 6·40765 | 11·15461 | 0·00000 | 0·00006 | 0·00001 | 11·15468 | 57·4436 | 79·959 |
| 12. | D | V. | 6·38180 | 11·10942 | 0·00025 | 0·00012 | 0·00001 | 11·10930 | 57·4456 | 79·952 |
| 13. | D | V. | 6·23696 | 10·85722 | 0·00005 | 0·00004 | 0·00001 | 10·85722 | 57·4453 | 79·953 |
| | | | | | | Average .. .. .. .. .. .. .. | | | 57·4452 | 79·953 |
| 14. | E | I. | 9·18778 | 15·99383 | 0·00014 | 0·00019 | 0·00004 | 15·99392 | 57·4455 | 79·953 |
| 15. | E | I. | 8·01261 | 13·94828 | 0·00018 | 0·00009 | 0·00007 | 13·94826 | 57·4452 | 79·953 |
| 16. | E | I. | 10·48638 | 18·25467 | 0·00025(*a*) | 0·00007 | 0·00001 | 18·25452 | 57·4454 | 79·953 |
| | | | | | | Average .. .. .. .. .. .. .. | | | 57·4454 | 79·953 |
| 17. | E | III. | 8·59260 | 14·95790 | 0·00014 | 0·00016 | 0·00005 | 14·95797 | 57·4450 | 79·954 |
| 18. | E | III. | 8·97307 | 15·62013 | 0·00004 | 0·00007 | 0·00006 | 15·62022 | 57·4452 | 79·953 |
| | | | | | | Average .. .. .. .. .. .. .. | | | 57·4451 | 70·954 |
| | Total .. .. | | 121·67653 | | | | | 211·81305 | 57·4452 | 79·953 |
| | | | | | | Average of all eighteen determinations.. | | | 57·4453 | 79·953 |
| | | | | | | Average of last seven determinations .. | | | 57·4453 | 79·953 |

(*a*) Fusion in bromine lost after the salt had been fused in air.

acid upon manganese dioxide, and dried by means of concentrated sulphuric acid. The apparatus for this purpose also was constructed wholly of glass. When the bromine was apparently completely displaced, the silver chloride was heated in the air for a few minutes to expel dissolved chlorine, and then was cooled and weighed. A repetition of the heating in chlorine seldom affected the weight of the salt more than a few hundredths of a m.grm., although occasionally a third heating was necessary to effect this result.

That no loss of silver chloride by volatilisation took place is certain for two reasons. In the first place the cover of the crucible and the delivery tube for the bromine when rinsed with ammonia and the solution treated with a slight excess of hydrochloric acid gave no visible opalescence in the nephelometer. In the second place the weight of the chloride became constant without difficulty. It has already been shown that silver chloride which has been fused in chlorine, if subsequently heated in air, retains no excess of chlorine (Baxter, *Proc. Am. Acad. Arts Sci.*, 1904, xl., 432; *Journ. Am. Chem. Soc.*, 1904, xxvi., 1591; Richards and Wells, Publications of the Carnegie Institution, No. 28, p. 59).

The following vacuum corrections were applied :—Silver bromide, +0·000041; silver chloride, +0·000071. (Richards and Stull have found the density of fused silver chloride to be 5·56). The atomic weight of chlorine referred to silver 107·930 is assumed to be 35·473.

Aside from the close agreement of all the results of Series I., the fact is to be emphasised that of the last seven analyses, which were consecutive, only two differ from the average of the series, 79·953, by as much as one one-thousandth of a unit. Furthermore, there is no evidence of any dissimilarity in the different preparations of bromine. Material which has received only two distillations from a bromide gives value no lower than bromine which has been thus treated four times. The various specimens of silver also show no difference in purity.

In the case of Series II., the extreme variation of the results is only four-thousandths of a unit, and only one of the thirteen experiments yielded a value which differs from the average by more than one-thousandth of a unit.

Finally, the difference between the averages of Series I. and II. is only seven ten-thousandths of a unit. It is extremely unlikely that constant errors could have affected both series equally, so that this striking agreement is strong proof that both series are free from such errors.

It has already been pointed out that the average of Stas's syntheses, 79·954, probably represents with considerable accuracy the atomic weight of bromine, and that certainly his determinations are more accurate than those of later experimenters. His syntheses are few in number, however, and differ among themselves by several thousandths of a unit, so that they do not define within this amount the constant in question. Their average, however, confirms the value obtained in this paper. From

all the experiments here described the number 79·953 seems to be the most probable value for the atomic weight of bromine if the atomic weight of silver is assumed to be 107·930.

TABLE II.—*The Atomic Weight of Bromine* (*Series* II.).

AgBr : AgCl.

(Ag = 107·930. Cl = 35·473).

| Number of analysis. | Sample of bromine. | Weight of silver bromide in vacuum. Grms. | Weight of silver chloride in vacuum. Grms. | Ratio. AgBr : AgCl. | Atomic weight of bromine. |
|---|---|---|---|---|---|
| 19. | II. | 8·03979 | 6·13642 | 131·0176 | 79·953 |
| 20. | II. | 8·57738 | 6·54677 | 131·0170 | 79·952 |
| 21. | II. | 13·15698 | 10·04221 | 131·0168 | 79·952 |
| Average .. | | .. .. .. | .. .. .. | 131·0171 | 79·952 |
| 22. | IV. | 12·71403 | 9·70413 | 131·0167 | 79·952 |
| 23. | IV. | 13·96784 | 10·66116 | 131·0162 | 79·951 |
| Average .. | | .. .. .. | .. .. .. | 131·0164 | 79·952 |
| 24. | V. | 13·08168 | 9·98469 | 131·0174 | 79·953 |
| 25. | V. | 12·52604 | 9·56059 | 131·0175 | 79·953 |
| 26. | V. | 11·11984 | 8·48733 | 131·0170 | 79·952 |
| 27. | V. | 8·82272 | 6·73402 | 131·0172 | 79·953 |
| Average .. | | .. .. .. | .. .. .. | 131·0173 | 79·953 |
| 28. | I. | 11·93192 | 9·10721 | 131·0162 | 79·951 |
| 29. | I. | 12·53547 | 9·56767 | 131·0190 | 79·955 |
| Average .. | | .. .. .. | .. .. .. | 131·0176 | 79·953 |
| 30. | III. | 17·15021 | 13·09009 | 131·0167 | 79·952 |
| 31. | III. | 10·31852 | 7·87572 | 131·0168 | 79·952 |
| Average .. | | .. .. .. | .. .. .. | 131·0168 | 79·952 |
| Total .. | | 153·94242 | 117·49801 | 131·0170 | 79·952 |
| Average of all thirteen experiments | | | | 131·0171 | 79·952 |
| Average of Series I. and II. .. | | | | | 79·953 |

In conclusion, attention may be called to the fact that a diminution in the atomic weight of bromine raises slightly all atomic weights resulting from the analysis of metallic bromides by precipitation with silver.

I am deeply indebted to the Carnegie Institution of Washington and to the Cyrus M. Warren Fund for Research in Harvard University for assistance in pursuing this investigation.

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THE

## ESTIMATION OF FLUORINE IODOMETRICALLY.

By ALBERT HILEMAN.

IT is obvious that the reaction by which fluosilicic acid liberates iodine from a mixture of potassium iodide and potassium iodate may be turned to account in the analysis of fluorides as well as in the determination of fluosilicic acid provided the course of action is regular.

Upon testing the action of hydrofluosilicic acid upon the iodide-iodate mixture, it was found that, while iodine is liberated freely in the cold, a complete reaction was not obtained in the course of several hours—the amount of iodine liberated indicating that an acid other than fluosilicic acid as a unit was acting. It appeared, however, that on boiling the mixture nearly one equivalent of iodine is liberated for every equivalent of fluorine present as fluosilicic or hydrofluoric acid. The reaction may be written $5KI + KIO_3 + H_2SiF_6 = 6KF + 6I + SiO_2 + H_2O$.

To the fluosilicic acid in a flask was added a neutral solution of potassium iodide and iodate in excess, and the flask closed with a glass stopper fitted with a trap containing a solution of potassium iodide to retained volatilised iodine. The solution in the flask was heated to boiling, then cooled, and, together with the contents of the trap, titrated with a standard solution of thiosulphate.

In Section A of Table I. are given the results obtained with a solution of commercial fluosilicic acid. Titrations with sodium hydroxide and comparative iodometric determinations are given. In Section B of Table I. the results of similar experiments with fluosilicic acid made by the action of hydrofluoric acid on an excess of silica are given.

The indications by the iodometric method are lower than those of the alkalimetric method of titration by about 0·0008 grm., on the average. This fact would indicate that the iodine liberated does not quite correspond to the complete hydrolysis of fluosilicic acid indicated by the theoretical equation.

Likewise Table II. shows the results obtained by applying the iodometric method to the silicon fluoride eliminated from calcium fluoride, according to the method proposed in a previous paper (*Am. Journ. Sci.*, xxii., 329).

TABLE I.

| $H_2SiF_6$. | Standard $NaOH_8$. | Standard $Na_2S_2O_3$. | Fluorine found. |
|---|---|---|---|
| | | A. | |
| | (1 c.c. = 0·005137 of fluorine). | (1 c.c. = 0·002335 of fluorine). | |
| C.c. | C.c. | C.c. | Grm. |
| 25 | 10·82 | — | 0·0556 |
| 25 | 10·87 | — | 0·0559 |
| 25 | 10·83 | — | 0·0557 |
| 25 | — | 23·54 | 0·0549 |
| 25 | — | 23·52 | 0·0049 |
| 25 | — | 23·48 | 0·0548 |
| 25 | — | 23·50 | 0·0548 |
| 25 | — | 23·45 | 0·0548 |
| 25 | — | 23·48 | 0·0548 |
| | | B. | |
| | (1 c.c. = 0·005137 of fluorine). | (1 c.c = 0·002441 of fluorine). | |
| 25 | 9·08 | — | 0·0466 |
| 25 | 9·05 | — | 0·0464 |
| 25 | 9·05 | — | 0·0464 |
| 25 | — | 18·78 | 0·0458 |
| 25 | — | 18·80 | 0·0459 |

Calcium fluoride was treated in the apparatus figured by the method described, the silicon fluoride was absorbed in water, and after separating the mercury used in the apparatus by means of a separating funnel, the iodide-iodate mixture was added to the solution, and the iodine liberated was titrated by sodium thiosulphate.

TABLE II.

| $CaF_2$. | (1 c.c. = 0·002335). $Na_2S_2O_3$. | Fluorine. Theory. | Found. | Error. |
|---|---|---|---|---|
| Grm. | | | | |
| 0·2500 | 51·35 | 0·1216 | 0·1199 | 0·0017 |
| 0·2300 | 46·75 | 0·1119 | 0·1091 | 0·0028 |
| 0·2300 | 47·15 | 0·1119 | 0·0100 | 0·0019 |
| NaF. | | | | |
| 0·2000 | 38·50 | 0·0903 | 0·0899 | 0·0014 |

The average error of −0·0019 grm. is considerably greater than that of the alkalimetric method, 0·0008 grm. It appears, therefore, that, while the iodometric method of determining fluorine in fluorides may in special cases present some advantages, it does not equal in accuracy the alkalimetric method when it is properly conducted.—*American Journal of Science*, [4], xxii., p. 383.

# THE USE OF THE ROTATING CATHODE FOR THE ESTIMATION OF CADMIUM TAKEN AS THE SULPHATE.*

By CHARLES P. FLORA.

In a recent paper from this laboratory (Gooch and Medway, *Am. Journ. Sci.*, 1903, [4], 320) has been described the application of the rotating cathode to the rapid estimation of copper, silver, and nickel; and, in a later paper (Medway, *Am. Journ. Sci.*, 1904, [4], xviii., 56), its fitness for the estimation of cadmium as well as several other metals has been shown. The object of the present investigation has been to more thoroughly study the conditions under which cadmium may be estimated by this means. The apparatus used was that described in the previous papers. Since it had already been shown (*loc. cit.*) that cadmium taken in the form of the sulphate can be estimated by deposition of a solution slightly acidulated with sulphuric acid, this formed the natural point of departure.

## I. *In Solutions containing Sulphuric Acid.*

A solution of cadmium sulphate was prepared, containing approximately 16·6 grms. of the salt to the litre of water. Portions of this solution were carefully measured from a burette, diluted to the desired volume, a few drops of dilute sulphuric acid (1 : 4) added, the proper connections made, and the electrolysis conducted as previously described. The results obtained upon two different solutions are given in Table I.

TABLE I.

| No. of expt. | Sol. taken. C.c. | $H_2SO_4$ (1:4). Drops. | Time. Mins. | Current reading = Ampères. | N.D.$_{100}$. Ampères. | E.M.F. approx. Volts. | Cd found. Grm. |
|---|---|---|---|---|---|---|---|
| | | | | *Solution* A. | | | |
| 1. | 15 | 5 | 18 | 0·4—1·0 | 1·2—3·0 | 8 | 0·1111 |
| 2. | 15 | 5 | 10 | 0·4—0·5 | 1·2—1·5 | 8 | 0·1090 |
| 3. | 15 | 5 | 16 | 0·4—0·9 | 1·2—2·7 | 8 | 0·1115 |
| 4. | 15 | 7 | 35 | 0·5—1·0 | 1·5—3·0 | 8 | 0·1117 |
| 5. | 15 | 12 | 25 | 1·0—1·5 | 3·0—4·5 | 8 | 0·1115 |
| 6. | 15 | 10 | 35 | 1·0—1·5 | 3·0—4·5 | 8 | 0·1120 |
| 7. | 15 | 18 | 30 | 1·5—2·0 | 4·5—6·0 | 8 | 0·1119 |
| 8. | 15 | 15 | 25 | 1·5—2·0 | 4·5—6·0 | 8 | 0·1117 |
| 9. | 30 | (*a*) | 15 | 3·0—4·0 | 9·0—12·0 | 8 | 0·2235 |
| 10. | 20 | 12 | 35 | 2·0—3·0 | 6·0—9·0 | 8 | 0·1491 |
| 11. | 15 | (*a*) | 60 | 2·0 | 6·0 | 8 | 0·1120 |
| | | | | *Solution* B. | | | |
| 1. | 20 | | 27 | 1·0—1·5 | 3·0—4·5 | 7·9 | 0·0816 |
| 2. | 25 | | 30 | 2·0—3·0 | 6·0—9·0 | 7·9 | 0·1018 |
| 3. | 25 | | 55 | 2·5—4·0 | 7·5—12·0 | 7·6 | 0·1019 |
| 4. | 30 | | 25 | 2·0—2·5 | 6·0—7·5 | 12·0 | 0·1224 |
| 5. | 30 | | 20 | 1·0 | 3·0 | 7·8 | 0·1223 |
| 6. | 30 | | 10 | 1·5—2·5 | 4·5—7·5 | 7·8 | 0·1226 |

(*a*) Indefinite.

In experiments numbered 1 to 4, the liquid at the end of the period indicated showed traces of cadmium remaining, but in the seven experiments following these the cadmium was all deposited upon the cathode in a satisfactory condition. These results were therefore taken as indicating the standard of the solution used, the mean of the series showing the presence of 0·007454 grm. of cadmium in each c.c. of the solution.

In a second solution which it became necessary to standardise the results given under Solution B were obtained.

The mean of these six experiments gives a value of 0·10194 grm. of cadmium for every 25 c.c. of the solution, or 0·0040776 grm. for each c.c. This value was taken as the standard whenever this solution was used.

One point which was not mentioned in the former paper (*loc. cit.*) on the estimation of cadmium by this method, but which is of much importance, is that of dilution. The earlier experiments in this work were performed at a dilution of from 65 c.c. to 75 c.c. Much trouble was experienced, however, at this dilution; for the last traces of the metal were driven from the solution only with extreme difficulty and with much loss of time, as may be noted by comparing the time interval of most of the experiments with the shorter interval of the last two experiments of the second series, where the dilution was 45 to 50 c.c. Moreover, it was found advisable, in order to avoid mechanical loss, to deposit not more than 0·2 grm. to 0·25 grm. of the metal upon the cathode, while even smaller quantities are to be preferred. The current density must also be kept within the limits indicated; for otherwise a spongy deposit may result. Cadmium seems to be especially liable to the formation of these spongy, unweighable deposits, and the greatest difficulties experienced in this investigation have come from this behaviour of the metal.

The best condition, therefore, may be briefly summarised as follows:—Cadmium sulphate, equivalent to not more than 0·2 c.c. to 0·25 grm. of the metal, is dissolved in 45 c.c. to 50 c.c. of water; ten to fifteen drops of dilute sulphuric acid are added; and the proper connections made and the solution subjected to electrolysis as described, fifteen minutes being sufficient time for the complete deposition of the metal upon the cathode. It is not necessary to heat the liquid, as the passage of such large currents soon heats it sufficiently. When electrolysis is complete, the excess of sulphuric acid may be destroyed with a slight excess of ammonia water, the current broken, and the cathode removed, thoroughly rinsed with water and alcohol, and dried by waving over a free flame. If the deposit is not spongy the drying is a matter of only a few moments, and there is no danger of oxidising the metallic deposit. If it is preferred, the current may be reduced by interposed resistance, the rotation stopped, and the liquid readily syphoned without danger of injuring the metallic coating.

## II. *In Solutions containing Acetates.*

The next method to be studied in its application to the rotating cathode was the use of solutions containing acetates, as recommended by Edgar F. Smith. Originally, Smith used a solution obtained by dissolving cadmium oxide in acetic acid (*Ber.*, 1878, xi., 2048), but later found that the electrolysis proceeded equally well in solutions containing the nitrate, chloride, or sulphate of cadmium with an excess of sodium acetate (*Am. Chem. Journ.*, 1880, ii., 41). In the study of the application of this method to the estimation of cadmium, taken as the sulphate, upon the rotating cathode, two methods of proceeding were followed, both of which had been previously used by Exner in his work upon the rotating anode (*Journ. Am. Chem. Soc.*, 1903, xxv., 896). In Series A, Table II., measured amounts of cadmium sulphate solution were run off from a burette, the indicated amount of sodium acetate was added in solution, a small amount of potassium sulphate was added to increate the conductivity of the solution, the whole diluted to the desired volume, and electrolysis conducted as with the solution containing sulphuric acid. In Series B, the cadmium in the measured solution was precipitated as the hydroxide with a sodium hydrate solution, the precipitate dissolved in a very slight excess of acetic acid, potassium sulphate added as before, and the solution subjected to electrolysis.

In both series the volume of the solution was about 60 c.c. to 65 c.c. The sixth experiment in each series will indicate the result when the greater concentration of 45 c.c. to 50 c.c. was tried. In these cases the precipitate showed a tendency to sponginess, which was more noticeable in Series A. At the greater dilution, the deposition of the cadmium proceeds rapidly and satisfactorily; the deposit is rather crystalline, fairly compact, and easily washed, so that the method forms one of the very best where the cadmium is taken in the form of the sulphate; the chloride and nitrate behave differently, and will be treated later. The second modification seemed to give deposits more

* Contributions from the Kent Chemical Laboratory of Yale University. From the *American Journal of Science*, xx., p. 268.

TABLE II.

| No. | Cd taken. Grm. | $NaOC_2H_3O$. Grms. | $K_2SO_4$. Grm. | Current reading = Ampères. | N.D.$_{100}$. Ampères. | E.M.F. Volts. | Time. Minutes. | Cd found. Grm. | Error. Grm. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | *Series* A. | | | | | |
| 1. | 0·1864 | 1·5 | 0·5 | 2·0 | 6·0 | 8·0 | | (*a*) | — |
| 2. | 0·1491 | 2·0 | 1·0 | 1·5 | 4·5 | 8·0 | 15 | (*b*) | — |
| 3. | 0·1118 | 0·5 | 1·0 | 1·0 | 3·0 | 8·0 | 20 | 0·1121 | +0·0003 |
| 4. | 0·1491 | 1·5 | 0·5 | 0·9 | 2·7 | 8·0 | 15 | 0·1494 | +0·0003 |
| 5. | 0·1491 | 1·5 | 0·5 | 0·9 | 2·7 | 8·0 | 15 | 0·1496 | +0·0005 |
| 6. | 0·1223 | 1·5 | 0·5 | 0·75 | 2·25 | 7·5 | 20 | 0·1237 | +0·0014 |
| | | | | *Series* B. | | | | | |
| 1. | 0·1491 | NaOH. Excess | 0·5 | 1·25 | 3·75 | 8·0 | 10 | 0·1496 | +0·0005 |
| 2. | 0·1491 | 0·2 | 0·5 | 0·8 | 2·4 | 8·0 | 15 | 0·1491 | 0·0000 |
| 3. | 0·1491 | 0·2 | 0·5 | 0·8 | 2·4 | 8·0 | 15 | 0·1493 | +0·0002 |
| 4. | 0·1223 | 0·5 | 0·2 | 1·0 | 3·0 | 12·0 | 20 | 0·1223 | 0·0000 |
| 5. | 0·1223 | 0·5 | 0·2 | 1·0 | 3·0 | 12·0 | 20 | 0·1223 | 0·0000 |
| 6. | 0·1223 | 0·2 | 0·5 | 1·25 | 3·75 | 7·5 | 10 | 0·1227 | +0·0004 |

(*a*) Did not weigh, as precipitate was non-adherent. Current too high for quantity of cadmium present.
(*b*) Deposits spongy and blistered. Too much electrolyte present.

TABLE III.

| No. | Cd taken. Grm. | NaOH. Grms. | KCN. Grm. | Current reading = Ampères. | N.D.$_{100}$. Ampères. | E.M.F. Volts. | Time. Minutes. | Cd found. Gem. | Error. Grm. |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 0·1491 | 1·5 | 0·5 | 2·5 | 7·5 | 8 | 35 | 0·1498 | +0·0007 |
| 2. | 0·1491 | 1·0 | 0·5 | 2·5—4·5 | 7·5—13·5 | 8 | 30 | 0·1490 | −0·0001 |
| 3. | 0·1223 | 1·5 | 1·0 | 2·5 | 7·5 | 8 | 35 | 0·1225 | +0·0002 |

TABLE IV.

| No. | Cd taken. Grm. | $Na_4P_2O_7$. Grm. | $NH_4OH$. | Current = Ampères. | N.D.$_{100}$. Ampères. | E.M.F. Volts. | Time. Minutes. | Cd found. Grm. | Error. Grm. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | *Series* A. | | | | | |
| 1. | 0·1491 | 0·5 | 15 c.c. (1 : 4) | 1·0—1·5 | 3·0—4·5 | 8 | 15 | 0·1498 | +0·0007 |
| 2. | 0·1491 | 0·5 | Excess | 0·4 | 1·2 | 8 | 15 | 0·1489 | −0·0002 |
| 3. | 0·1864 | 0·5 | 15 c.c. (conc.) | 0·7 | 2·1 | 8 | 15 | 0·1869 | +0·0005 |
| | | | | *Series* B. | | | | | |
| | | | $H_3PO_4$ (1·7 sp. gr.). | | | | | | |
| 4. | 0·1491 | 1·0 | 1·0 c.c. | 1·0 | 3·0 | 8 | 30 | 0·1496 | +0·0005 |
| 5. | 0·1864 | 1·0 | 1·0 ,, | 1·0—1·5 | 3·0—4·5 | 8 | 30 | 0·1857 | −0·0006 |
| 6. | 0·1491 | 1·0 | 1·0 ,, | 1·0 | 3·0 | 8 | 30 | 0·1493 | +0·0002 |
| | | | | *Series* C. | | | | | |
| | | | $H_2SO_4$. | | | | | | |
| 7. | 0·1491 | 1·0 | 2 c.c. (1 : 4) | 2·0—2·5 | 2·0—7·5 | 8 | 30 | 0·1501 | +0·0010 |
| 8. | 0·1864 | 0·5 | Excess | 1.0—2·0 | 3·0—6·0 | 8 | 35 | 0·1862 | −0·0002 |
| | | | | *Series* D. | | | | | |
| | | | HCl. | | | | | | |
| 9. | 0·1491 | 0·5 | Slight excess | 1·0 | 3·0 | 8 | 37 | 0·1499 | +0·0008 |
| 10. | 0·1491 | 0·5 | ,, ,, | 1·0 | 3·0 | 8 | 36 | 0·1486 | −0·0005 |

In Nos, 1 and 3 a small amount of dilute sulphuric acid was added to increase the conductivity of the solution, but the time was not reduced thereby, while the resulting deposit was slightly spongy.

In No. 5 the calcium was not quite all precipitated.
In No. 7 the precipitate was spongy.

TABLE V.

| No. | Cd taken. Grm. | $HNa_2PO_4$. Grm. | $H_2PO_4$ (1:7). C.c. | Total vol C.c. | Current = Ampères. | N.D.$_{100}$. Ampères | E.M.F. Volts. | Time. Minutes. | Cd found. Grm. | Error. Grm. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 0·1491 | 0·5 | 1·0 | 75 | 1·0—1·2 | 3·0—3·6 | 8 | 20 | 0·1477 | −0·0014 |
| 2. | 0·1491 | 0·5 | 5·0 | 75 | 2·0—2·5 | 6·0—7·5 | 8 | 23 | 0·1496 | +0·0005 |
| 3. | 0·1491 | 0·5 | 5·0 | 75 | 2·0—1·5 | 6·0—4·5 | 8 | 30 | 0·1508 | +0·0017 |
| 4. | 0·1491 | 0·5 | 3·0 | 75 | 2·5 | 7·5 | 12 | 25 | 0·1502 | +0·0011 |
| 5. | 0·1491 | 0·5 | 4·0 | 75 | 2·5 | 7·5 | 8 | 25 | 0·1485 | −0·0006 |
| 6. | 0·1491 | 0·5 | 2·0 | 75 | 2·5 | 7·5 | 12 | 35 | 0·1501 | +0·0010 |
| 7. | 0·1864 | 0·25 | 2·0 | 75 | 2·0—3·0 | 6·0—9·0 | 12 | 40 | 0·1861 | −0·0003 |
| 8. | 0·1491 | 0·3 | 1·5 | 75 | 3·5 | 10·5 | 12 | 30 | 0·1502 | +0·0011 |
| 9. | 0·1019 | 0·25 | 5·0 | 75 | 2·5—3·0 | 7·5—9·0 | 7·8 | 30 | 0·1024 | +0·0005 |
| 10. | 0·1019 | 0·25 | 5·0 | 75 | 3·0—3·5 | 9·0—10·5 | 7·8 | 30 | 0·1027 | +0·0008 |
| 11. | 0·1223 | 0·2 | 5·0 | 75 | 3·0—3·5 | 9·0—10·5 | 7·8 | 40 | 0·1221 | −0·0002 |

No. 1.—Not all out.
No. 2.—Slight yellow colour with $H_2S$.
No. 3.—Slight yellow with $H_2S$.
No. 4.—Spongy.

No. 5.—Not all out.
No. 6.—Spongy.
No. 10.—Spongy.
No. 11.—Slight test with $H_2S$.

satisfactory than the first. Certain cautions, however, are to be observed. Not more than 0·1500 grm. may safely be estimated; the normal current density should not exceed 3·0 ampères if a spongy deposit is to be avoided; and, for the same reason, a large excess of electrolytes is to be avoided.

III. *In Solntions containing Cyanides.*

The deposition of cadmium from a solution of the double cyanide has always been very satisfactory, and the results with the rotating cathode were in complete accordance with previous work on this method. The range of conditions of current and quantity of electrolyte is broad, the deposit is a beautiful silvery plate, so compact as to be rubbed off only with difficulty, which dries very quickly; and although the complete deposition of the metal is not so rapid as it is from solutions containing sulphates or acetates, it is sufficiently rapid. Care should be taken to avoid foaming of the solution, as this retards somewhat the deposition of the final traces of cadmium. Generally, a volume of 65 c.c. to 70 c.c. was found most satisfactory. The solution was run off into a beaker of convenient size, the cadmium precipitated with sodium hydroxide, and the precipitate re-dissolved in potassium cyanide. The results obtained are given in Table III.

IV. *In Solutions containing Pyrophosphates.*

Brand (*Zeit. Anal. Chem.*, 1889, xxviii., 581) has recommended the use of a solution containing sodium pyrophosphate for the electrolytic estimation of metals, among others, cadmium; and the fitness of this solution for use with the rotating cathode was now studied. In each case the cadmium was precipitated with the indicated amount of sodium pyrophosphate, the precipitate dissolved in an excess of ammonium hydroxide (Series A), phosphoric acid of 1·7 specific gravity (Series B), sulphuric acid (Series C), or hydrochloric acid (Series D), and subjected to the action of the current. The volume of the solution was 60 c.c.

While fairly accurate results may be obtained, the method is neither so accurate as those previously described, nor are the conditions so flexible. Particular care must be used to avoid too large a current, as a spongy deposit may result. Table IV. gives the results obtained.

V. *In Solutions containing Phosphates.*

The use of a solution containing the orthophosphates dissolved in phosphoric acid has been recommended by Smith (*Am. Chem. Journ.*, 1890, xii., 329), and this solution was next tried. The results given in Table V. will show the scope of the modifications tried.

From this series of experiments it may be seen that the method may be made to give fair results if the following conditions are closely adhered to:—For a total volume of 75 c.c., the cadmium is precipitated with 0·25 grm. of hydrogen disodic phosphate, 5 c.c. of phosphoric acid (sp. gr. = 1·7 added), and the solution electrolysed with a current of about 8 volts potential. If the normal current density does not exceed 9 ampères, the deposit will be fair, and complete in about thirty minutes.

(To be continued).

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**Royal Institution.**—A General Monthly Meeting of the Members of the Royal Institution was held on the 3rd inst., His Grace the Duke of Northumberland, K.G., F.R.S., President, in the Chair. Mr. Cyril Davenport, Mr. G. S. Hein, Sir Henry Kimber, Bart., M.P., Major P. A. MacMahon, and Mrs. Robarts were elected Members. Prof. A. Righi, Prof. P. Lenard, Prof. W. C. Röntgen, Prof. J. H. van't Hoff, Prof. T. W. Richards, Prof. A. von Bäyer, Prof. K. J. Angström, and Prof. H. H. Hildebrandsson were elected Honorary Members of the Royal Institution. The Special Thanks of the Members were returned to Dr. M. M. Bleekrode for his gift of a portrait of the late Dr. L. Bleekrode, Hon. Mem. R.I.

## HYDROXYLAMINE-αβ-DISULPHONATES.*

### Structural Isomerides of Hydroximino-sulphates or Hydroxylamine-ββ-disulphonates.

By TAMEMASA HAGA,
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In a previous paper (*Journ. Coll. of Sci., Imp. Univ., Japan*, xix,, Art. 15), it was shown that Fremy's *meta. sulphasilate*, which till then had been considered to be constituted as an amine oxide, $O:N(SO_3K)_3$, is in reality a *hydroxylaminetrisulphonate*. The nature of the products of the proximate hydrolysis of the metasulphazilates seems to afford the strongest additional evidence that these salts are hydroxylaminesulphonates and, as such, mixed anhydrides of an acid sulphate and a hydroxylaminedisulphonate.

The ultimate hydrolysis of a hydroxylaminetrisulphonate, through intermediate stages, into hydroxylamine and an acid sulphate, is difficult to carry to completion (*Journ. Coll. of Sci., Japan*, xix., 15, 28), but the first stage of it, into a hydroxylaminedisulphonate and one-third of the quantity of acid sulphate that is produced in the ultimate hydrolysis, is very easily accomplished. The hydroxylaminedisulphonate thus obtained proves to be an entirely new salt, structurally isomeric with the corresponding *hydroxylaminedisulphonate* (Fremy's *sulphasotate*), from which it differs greatly in essential physical and chemical properties. The one is a ββ-derivative, the other an αβ-derivative of hydroxylamine. Which is which is determined by the behaviour of the two salts towards sodium amalgam. A salt of the series already known remains unaffected, whilst one of the new series decomposes (see *prox.*) into sulphate and aminemonosulphonate (sulphamate, aminosulphate), just as its parent salt, hydroxylaminetrisulphonate decomposes, in like circumstances, into sulphate and aminedisulphonate (iminosulphate). It must, therefore, have the αβ-constitution, as shown in the following equation, framed to express its decomposition by sodium:—

$$(SO_3Na).O.NH(SO_3Na) + H_2O + 2Na = (SO_3Na).ONa + NH_2(SO_3Na) + NaOH,$$

and the other salt have the ββ-constitution which it has always been assumed to have, $HON(SO_3Na)_2$. The activity of the αβ-salts towards sodium amalgam serves also to demonstrate their sulphatic constitution (derived from that of the hydroxylaminetrisulphonates) as the mixed anhydrides of an acid sulphate and a hydroxylaminemosulphonate.

(Two other examples of such mixed sulphatic anhydrides are any hydroxylaminetrisulphonate aad any hyponitrososulphate. Raschig, *Zeit. Angew. Chem.*, 1905, xviii. 1309, has recently adduced evidence that nitrosyl sulphate is, after all. not a sulphate but a nitrosulphonate, $O_2N.SO_3H$).

The action of potasium hydroxide upon the two salts seems clearly to establish the difference there is in their constitution. The old salt reverts to nitrite and sulphite when it is left, even in the cold, in a concentrated solution of the alkali (*Journ. Coll. of Sci., Japan*, vii., 40), whereas the new salt is only incompletely decomposed into sulphate, aminemonosulphonate, and nitrogen (see *prox.*), after several hours' digestion at 100° to 125° with the alkali. These results are exhibited by the following equations, the upper for the old or ββ-salt, and the lower for the new or αβ-salt:—

$$HON(SO_3K)_2 + 3KOH = 2(SO_3K)K + NO_2K + 2H_2O;$$

$$3(SO_3K)ONH(SO_3K) + 5KOH = 5(SO_3K)OK + NH_2(SO_3K) + N_2 + 3H_2O.$$

The lower of these equations recalls the action of heated alkalis upon hydroxylamine (Lossen) and upon hydroxylaminemonosulphonate (Claus). The upper equation brings out strongly the oximidic constitution of the ββ-salt.

It is an interesting fact that the course of the hydrolysis

* *Journal of the College of Science, Imperial University, Tokyo, Japan*, xxi., Article 6.

of the two salts in acidified solution is widely different, but it is a fact which cannot apparently be used to establish the nature of the difference in their constitution. The $\beta\beta$-or long-known salt, by losing one of its two sulphonate groups, readily passes into the hydroxylamine-$\beta$-monosulphonate, $HONH(SO_3K)$, whereas the new or $\alpha\beta$-disulphonate (see *prox.*) passes much less easily into acid sulphate and hydroxylamine itself (and products of its well-known decomposition), without ever affording evidence of any production of a monosulphonate, which in this case should have the $\alpha$-constitution, expressed by $(SO_3K)ONH_2$, and, as an amidogenium salt, be perhaps incapable of existence. The slowness with which an $\alpha\beta$-salt begins to hydrolyse is illustrated by the fact that a solution of the potassium salt will remain clear for five minutes at the common temperature after it has been mixed with hydrochloric acid and barium chloride, whereas a solution of the $\beta\beta$-salt will almost at once begin to show turbidity. When the hydrolysis of the $\alpha\beta$-salt proceeds in the absence of much or any hydrochloric acid, nitrogen and ammonia very largely take the place of the hydroxylamine which is obtained in nearly the theoretical quantity when the salt hydrolyses in presence of a sufficiently concentrated hydrochloric acid solution. The following equation expresses what principally happens in the absence of hydrochloric acid :—

$$3(SO_2K)ON(SO_3K)+3H_2O = 5(SO_3K)OH+N_2+(SO_3K)ONH_4.$$

Silver oxide and lead peroxide seem to be without action upon the $\alpha\beta$-salts in solution; they certainly do not produce the deeply coloured peroxylaminesulphonate which so strikingly results from their action upon the $\beta\beta$-salts. This difference accords with that indicated in the constitution of the two series of salts. A hydroxylamine-$\alpha\beta$-disulphonate also unexpectedly agrees with a hydroxylamine $\beta\beta$-disulphonate in not reducing copper or silver oxide in alkaline solution and is also inactive upon a solution of iodine in presence of sodium acid carbonate. A hydroxylaminemonosulphonate, $HONH(SO_3K)$, which, like it, has an aminic hydrogen atom in its constitution, has the activity of hydroxylamine upon both alkaline copper solution and upon alkali-bicarbonate iodine solution.

Like the $\beta\beta$-salts the hydroxylamine-$\alpha\beta$-disulphonates decompose with gentle explosion when heated. Also, like the $\beta\beta$-series, that of the $\alpha\beta$-disulphonates includes highly alkaline normal salts, such as $(SO_3K)ONK(SO_3K)$ and $(SO_3Na)ONNa(SO_3Na)$.

A concentrated solution of the disodium salt is not precipitated by silver nitrate, mercuric nitrate, lead nitrate, or barium chloride. A concentrated solution of basic lead acetate precipitates from it an oil, which becomes crystalline on standing. A concentrated solution of a potasium salt precipitates from it the very much less soluble potassium salt. Barium hydroxide gives a voluminous, apparently amorphous, precipitate, probably of a sodium barium salt.

The molecular magnitude of the normal or trisodium hydroxylamine-$\alpha\beta$-disulphonate (see *prox.*), as determined cryoscopically by means of melted Glauber's salt (Löwenherz), is that expressed by $O_7NS_2NA_3$, the same, therefore, as that found for the normal sodium $\beta\beta$-salt (*Journ. Coll. of Sci., Japan*, xix., Art. 15, 33). Remarkably, however (and it is a unique experience with this method, so far as has been ascertainable), the depression of the solidifying point of the sodium sulphate is at first much less than that which corresponds with the simple molecular weight, the number for which it only reaches and remains steady at, in the course of an hour or two and after several repetitions of re-melting and solidifying. It would seem from this that the solid salt consists of associated simple molecules which require time to separate from each other after dissolution in melted Glauber's salt.

The discovery of this new series of salts, establishing as it does the existence of significant structural isomerism in other than carbon compounds, should prove to be of very special interest, there being hardly any other instance known, except that of nitramine with hyponitrous acid, the existence of which is disputed by Hantzsch (*Zeit. Anorg. Chem.*, 1898, xix., 106), just because it would be the only case known in inorganic chemistry.

The subjoined scheme of equations may serve to show at a glance the relation by derivation of the new series of salts to the old series. A hydroxylamine-$\beta\beta$-disulphonate, a salt formed by the union of nitrous acid with a metasulphite, is oxidisable wholly into a peroxylaminesulphonate. This, by hydrolysis in presence of an alkali, becomes, to the extent of half its nitrogen, hydroxylaminetrisulphonate; to the extent of a fourth of its nitrogen, the $\beta\beta$-salt again; and, to the extent of the remaining fourth of its nitrogen, nitrous acid (nitrite) again. Lastly, by acid hydrolysis, the hydroxylaminetrisulphonate becomes sulphate and a hydroxylamine-$\alpha\beta$-disulphonate. From this it will be seen that, at most, only the half of the $\beta\beta$-salt comes out as the $\alpha\beta$-salt, one-fourth of it being regenerated and the remaining fourth reverting to its parent salts, of which the sulphite has suffered oxidation to sulphate.

$$4HNO_2+4S_2O_5K_2 = 4\overset{\beta\beta\text{-salt}}{HON(SO_3K)_2}$$

$$4\overset{\beta\beta\text{-salt}}{HON(SO_3K)_2}+2PbO_2 = 2[ON(SO_3K)_2]_2+2Pb(OH)_2;$$

$$2\,ON(SO_3K)_2]_2+H_2O = 2(SO_3K)ON(SO_3K)_2+\overset{\beta\beta\text{-salt}}{HON(SO_3K)_2}+NO_2H$$

$$2(SO_3K)ON(SO_3K)_2+2H_2O = \overset{\alpha\beta\text{-salt}}{2(SO_3K)ONH(SO_3K)}+2HO(SO_3K).$$

The return of an $\alpha\beta$-salt to the state of its $\beta\beta$-isomeride can hardly be looked hpon as possible, its own production having been due to oxidation of a fourth of the sulphonate groups into acid sulphate.

### *Salts.*

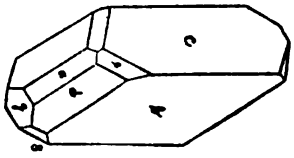
*Dipotassium Hydroxylamine - α β - disulphonate*, $(SO_3K)ONH(SO_3K)$. — Potassium hydroxylaminetrisulphonate, dissolved in ten times its weight of warm water (it is much less soluble in cold water—*Journ. Coll. of Sci., Japan*, xix., Art. 15, 8). soon begins to hydrolyse when its solution is quickly cooled and mixed with a drop of dilute sulphuric acid just before it would otherwise crystallise out again. The hydrolysis, to the end of its first stage, is complete in about four days. When the solution is deprived of sulphate and neutralised by the addition of barium carbonate or hydroxide, filtered, and evaporated, the new disulphonate is obtained in crystals, to the extent of at least two-thirds of the calculated yield. That hydrolysis of the trisulphonate proceeds to the extent shown in the equation (see *prox.*) in about four days and then proceeds much more slowly, has been ascertained both acidimetrically and by estimation of the sulphuric acid produced.

The dipotassium salt is an anhydrous salt, about twice as soluble in water as the corresponding (but hydrated) $\beta\beta$-salt. Of it 6·44 parts at 16·4°, 7·18 parts at 17·8°, and 8·05 parts at 20° dissolve in 100 parts of water. Its solution is neutral to litmus, to methyl-orange, and to phenolphthalein.

The salt forms hard monoclinic prisms which are sometimes short thick prisms, sometimes flattened tables, and sometimes long slender prisms or needles. Crystals of the one or other habit generally re-crystallise in that habit, but the salt is not dimorphous. A saturated solution of one form of the salt is saturated also towards another form of it, whilst the two forms will lie side by side unchanged for a length of time in the same mother-liquor. Prof. Jimbo has kindly supplied the following account of his examination of a short thick prism :—A monoclinic crystal, developed perfectly on one end of the clinodiagonal, about 6 m.m. long, was measured by means of a contact goniometer, only two angles, *c e* and *e d*, having been

measured by reflection. The faces *a* and *g* were depressed; the other faces also did not give good images. Seven faces were recognised; one other could not be determined.

| | | |
|---|---|---|
| (*a*) .. .. .. | $\infty P\bar{\infty}$ | *bd* = 133° 25′ |
| (*b*) .. .. .. | $\infty P\bar{\infty}$ | *ce* = 144° 27′ |
| (*c*) .. .. .. | oP | *ef* = 127° 53′ |
| (*d*) .. .. .. | $\infty P$ | *ed* = 141° 25′ |
| (*e*) .. .. .. | −P | *df* = 126° 15′ |
| (*f*) .. .. .. | P (?) | *cg* = 117° |
| (*g*) .. .. .. | $\frac{1}{2}P\bar{\infty}$ (?) | |



The results of analyses, of (A) the tabular form and of (B) the acicular form ol the salt, are as follows:—

| | | |
|---|---|---|
| A. | 0·2863 gave 0·1845 potassium sulphate. | Potassium = 28·98 |
| | 0·2105 gave 0·3673 barium sulphate. | Sulphur = 23·96 |
| | 0·2739 gave 12·58 c.c. moist nitrogen at 19·5° and 756·1 m.m. | Nitrogen = 5·22 |
| B. | 0·2679 gave 0·1751 potassium sulphate. | Potassium = 28·74 |
| | 0·2684 gave 11·9 c.c. moist nitrogen at 16·7° and 765·5 m.m. | Nitrogen = 5·19 |

$HO_7NS_2K_2$ requires potassium, 29·06; sulphur, 23·79; nitrogen, 5·21 per cent. In all analyses given in this paper sulphur was determined by heating the salt with hydrochloric acid in a sealed tube at 180° for five hours or at 200° for two hours.

*Tripotassium Hydroxylamine - αβ - disulphonate*, $(SO_3K)ONK(SO_3K)_2,2H_2O$.—This salt is precipitated, at first as an oil, when alcohol is added to its concentrated aqueous solution, prepared by dissolving the disulphonate in a little hot water and adding to it the calculated quantity of potassium-hydroxide solution. The oily salt slowly solidifies into lumps of microscopic crystalline plates. The quantity obtained should be about equal in weight to that of the disulphonate used, the calculated quantity being five parts from four. It is very soluble in water. Its solution is not precipitated by barium chloride, in this respect being unlike a solution of the corresponding ββ-salt. It is caustic in taste, and explodes suddenly when heated.

*Analysis.*

| | |
|---|---|
| 0·1696 gave 0·1286 potassium sulphate. | Potassium = 34·05 |
| 0·2588 gave 0·1944 potassium sulphate. | Potassium = 33·73 |
| 0·1568 gave 0·2343 barium sulphats. | Sulphur = 20·52 |

$H_4O_9NS_2K_3$ requires potassium, 34·18; sulphur, 18·66 per cent.

The *disodium salt*, $(SO_3Na)ONH(SO_3Na)$, is like the ββ-salt, anhydrous. The very soluble sodium hydroxylamine-trisulphonate is dissolved in five times its weight of water and acidified with dilute sulphuric acid. In two or three days, at the ordinary temperature, it will have all hydrolysed, and the solution is then to be neutralised with sodium carbonate. On exposure for a night in the ice chamber, almost all the sodium sulphate will crystallise out, and then the mother-liquor can be evaporated to get the new salt. Like corresponding ββ-salt, this salt forms hard masses firmly adhering to the sides of the vessel. These masses are stellar or warty groups of microscopic thick rhombic plates. The salt is exceedingly soluble in water, from which it can be nearly all precipitated by alcohol. Two preparations of the salt were analysed (I. and II.):—

| | | |
|---|---|---|
| I. | 0·2209 gave 0·1313 sodium sulphate. | Sodium = 19·28 |
| | 0·1059 gave 0·2096 barium sulphate. | Sulphur = 27·17 |
| | 0·5151 gave 26·45 c.c. moist nitrogen at 17° and 756·8 m.m. | Nitrogen = 5·94 |
| II. | 0·2509 gave 0·1502 sodium sulphate. | Sodium = 19·41 |
| | 0·0959 gave 0·1910 barium sulphate. | Sulphur = 27·35 |

$HO_7NS_2Na_2$ requires sodium, 19·43; sulphur, 27·02; nitrogen, 5·92 per cent.

The *trisodium salt*, $(SO_3Na)ONNa(SO_3Na),2H_2O$, is prepared just in the same way as the tripotassium salt. It is obtained as a crystalline powder. For determinations of its molecular magnitude, see *prox*.

| | |
|---|---|
| 0·1450 gave 0·1054 sodium sulphate. | Sodium = 23·57 |
| 0·2269 require 7·56 c.c. N/10 hydrochloric acid with methyl-orange as indicator. | Alkalinity as sodium = 7·66 |
| 0·3594 gave 0·5698 barium sulphate | Sulphur = 21·75 |

$H_4O_9NS_2Na_3$ requires sodium 23·41; alkalinity sodium, 7·8; sulphur, 21·71 per cent.

*Diammonium salt*, $(SO_3NH)ONH(SO_3NH_4)$. — Ammonium hydroxylaminetrisulphonate (*Journ. Coll. of Sci., Japan*, xix., Art. 15, 9) hydrolyses in the same way as the sodium salt. The ammonium acid-sulphate is got rid of by adding just enough barium hydroxide solution, filtering, and evaporating, at first at a gentle heat, and then in the cold over sulphuric acid under reduced pressure. It occurs as small thick plates, which are somewhat hard, and as nodules composed of minute tabular crystals. It is a very soluble salt, 3 parts dissolving normally in just 2 parts of water at 18°, but it is very apt to form supersaturated solutions. It is a more stable salt than the corresponding ββ-salt. Its crystals are probably anhydrous, but those analysed showed the presence of 0·25 $H_2O$ per molecule.

| | |
|---|---|
| 0·3559 gave 0·7189 barium sulphate. | Sulphur = 27·74 |
| 0·2320 gave 35·5 c.c. moist nitrogen at 16·2° and 754·5 m.m. | Nitrogen (per cent) = 18·18 |

$H_9O_7N_3S_2$ requires sulphur, 28·21; nitrogen, 18·53. With $\frac{1}{2}H_2O$ added, it requires sulphur, 27·66; nitrogen, 18·17 per cent.

*Barium Salts.*—Barium salts have not been prepared in a state suited for satisfactory determination of their nature. Evaporation of a solution of the ammonium salt with excess of barium hydroxide in a vacuum over sulphuric acid to a small volume removed all ammonia. After removal of the excess of barium hydroxide by carbon dioxide, the filtered solution was further evaporated in the desiccator. First, a viscid liquid and then a bulky friable, porous mass, devoid of crystalline character, were obtained. The latter was not quantitatively analysed, but it yielded, when hydrolysed, barium sulphate and hydroxylamine sulphate in crystals which were further identified by a very satisfactory sulphuric acid determination. The product was therefore undoubtedly a barium hydroxylamine-αβ-disulphonate. By using less barium hydroxide, crystallised ammonium barium salts of varying composition may be obtained. One quantitatively examined had a composition corresponding fairly well with that of a compound of six molecules of the diammonium salt with one molecule of the two-thirds normal barium salt.

*Molecular Magnitude of Trisodium Hydroxylamine-αβ-Disulphonate.*

By Löwenherz's method, the molecular magnitude of the trisodium hydroxylamine-ββ-disulphonate has been found to be (anhydrous) 233 and 239·6, whilst $O_7NS_2Na_3$ requires 259·35 (*Journ. Coll. Sci., Japan*, xix., Art. 15, 33). By the same method, the following approximations to the

same number have been obtained for the $\alpha\beta$-salt, namely, 269·6, 279·3, and 256·4, using the constant, 32·6, for sodium sulphate found by Löwenherz. The details of these determinations of the molecular magnitude of the $\alpha\beta$-salt are specially interesting (see above). Of this salt, 0·8371, dissolved in 40·48 melted Glauber's salt, produced a depression of 0·22° in the crystallising point, corresponding with the molecular weight, 306·2. After solidifying and melting three times, the depression reached 0·24°, and remained at that, which corresponds with 269·6. There was now added 0·5848 more of the salt, and the depression due to this addition was at first only 0·005°, corresponding with a molecular weight of 9416; that is about forty times the normal magnitude. On allowing the mixture to solidify and re-melt, the depression grew in amount until at the sixth repetition it reached its maximum, corresponding with the simplest formula of the salt. The whole quantity, 1·4219, now caused a depression which gave the molecular magnitude as 279·3. Adding now 0·9026, the additional depression was at first only 0·04°, corresponding with a molecular weight of 1878, which is about eight times the simple molecule. But, again, as before, after several times repeated melting and solidifying, the normal depression was reached and remained constant, and the total quantity of the salt, namely, 2·3245, gave a depression of 0·73°, indicating the molecular magnitude, 256·4.

*Reduction of the Disodium Salt by Sodium Amalgam.*

Disodium hydroxylamine-$\alpha\beta$-disulphonate, 0·4811 grm., was shaken with 12 grms. of 3 per cent sodium amalgam (which acts very slowly on it) and left with it, with occasional shaking, for three days. Much sodium remained unconsumed. The solution was rendered neutral to phenolphthalein by acetic acid, and the sulphate present precipitated as barium sulphate. Of the sulphur in the quantity of salt taken, 13·73 per cent were thus found as sulphate, instead of 13·51, the calculated third. The aminemonosulphonate in the filtrate from this sulphate was hydrolysed by heating the solution at 150° for three hours in a sealed tube with hydrochloric acid. It thus yielded the rest of the sulphur as sulphate, a result which, effected at such a temperature, showed that that sulphur was all in direct union with nitrogen and that none of the hydroxlaminedisulphonate had been left undecomposed by the sodium. As a check, the ammonia, the other product of the hydrolysis of the aminemonosulphonate, was also determined and found equal to 5·5 per cent instead of 5·94 per cent, the full amount. The production of aminemonosulphonate by the reduction of the hydroxylamine-$\alpha\beta$-disulphonate was further established quantitatively in a separate experiment, in which, after the reduction, the aminesulphonate was precipitated characteristically by mercuric nitrate and the acid itself, after recovery from irs mercury salt, crystallised out, and otherwise tested.

(To be continued).

## NOTICES OF BOOKS.

*Practical Methods of Inorganic Chemistry.* By F. Mollwo Perkin, Ph.D. London: Archibald Constable and Co., Ltd. 1906.

The training in preparative inorganic chemistry which is provided in this book should be of great value to the student, and should help to fix his knowledge of both general and special methods in inorganic chemistry, which are usually not so much emphasised as the corresponding processes in organic work. Although the larger text-books will be found to contain details of the preparation of most of the substances described in this book the arrangement of them in groups is a point which will recommend the manual, and the experimental details are so fully and carefully explained that failure should be impossible provided the directions are followed. The choice of substances to be prepared is excellent; some which are comparatively rare, but whose preparation has specially interesting features, being included; thus, for example, the nature of colloidal solutions and their preparation are discussed. All the methods described have been thoroughly tested, and the book can be confidently recommended to be used as a guide for laboratory work to supplement a course of qualitative analysis.

*Smaller Chemical Analysis.* By G. S. Newth, F.I.C., F.C.S. London, New York, and Bombay: Longmans, Green, and Co. 1906.

This book is an abridged edition of the qualitative section of the author's manual of qualitative and quantitative chemical analysis, which is already well known as a valuable work. The book contains an ordinary analytical course for the detection and separation of bases and radicals, grouped in the usual way, and gives general tables of dry and wet reactions with full directions and copious explanations. In addition a section is given on simple volumetric determinations, typical examples being included of neutralisation, oxidation, reduction, and precipitation processes, so that the book is very suitable for the use of candidates for the Senior Locals and similar examinations.

*Ausführliches Lehrbuch der Pharmazeutischen Chemie.* ("Complete Text-book of Pharmaceutical Chemistry"). Volume I., Part I. By Dr. Ernst Schmidt. Fifth Edition. Braunschweig: Friedrich Vieweg und Sohn. 1906.

The first volume of the fifth edition of this treatise deals with inorganic chemistry, and discusses the general physical and chemical properties and relations of the most important inorganic substances, their uses in medicine being specially emphasised. A thoroughly good grounding in inorganic chemistry is of great importance to pharmaceutical chemists, and with the help of this book the student should be enabled to lay a firm foundation for later and more advanced work, for the author has been careful to include descriptions of all those substances which are in any way connected with pharmaceutical chemistry, so that a more extended course is given than is generally considered necessary. Methods of detection and quantitative determination of the more important elements and compounds are described, and an introduction gives a short account of the theory of chemistry.

*Die Elektrochemischen Deutschen Reichspatente.* ("German Electro-chemical Patents"). By Dr. P. Ferchland and Dr. P. Rehländer. Halle-a-S.: Wilhelm Knapp. 1906.

These extracts from the German patent specifications will be a great assistance to the chemist who, in order to solve some technical electro-chemical problem, may be called upon to undertake the lengthy task of searching the records, and who has hitherto had no guide to aid him in this search. The class, number, and title of each patent is given, with the name of the patentee, and a short, and in some cases illustrated, abstract of the most important points in the specification; by means of an appendix the patents have been brought down to the latest possible date, while a list is given of the numbers of the patents which were still in force at the end of May, 1906. The merits and value of the processes are not, as a rule, criticised except when the editors have had special reasons for so doing. The extremely tedious work of preparing such a list as this must have taxed the patience of the compilers, but it was well worth doing, and will be appreciated by many; the book is well arranged, and valuable cross references are given which will be an additional help to those who want full information regarding the patents relating to any special question.

## MISCELLANEOUS.

**Royal Institution.**—The following are the Lecture Arrangements before Easter:—Mr. W. Duddell, a Christmas course of six experimentally Illustrated lectures on "Signalling to a Distance—from Primitive Man to Radio-telegraphy," adapted to a juvenile auditory; Prof. Percy Gardner, two lectures on "The Sculpture of Aegina in Relation to Recent Discovery"; Prof. A. C. Seward, two lectures on "Survivals from the Past in the Plant World"; Prof. W. Stirling, six lectures on "The Visual Apparatus of Man and Animals"; Dr. W. N. Shaw, two lectures on "Recent Advances in the Exploration of the Atmosphere"; Major P. A. MacMahon, two lectures on "The Standards of Weights and Measures"; Prof. W. W. Watts, two lectures on—(1) "The Building of Britain," (2) "Recent Light on Ancient Physiographies"; Dr. W. Martin, two lectures on "Old Dutch Painting and Painters"; Dr. C. W. Saleeby, two lectures on "Biology and Progress"; Sir Alexander Mackenzie, two lectures on "Latest Phases of Music" (with musical illustrations); and Prof. J. J. Thomson, six lectures on "Röntgen, Cathode, and Positive Rays." The Friday Evening Meetings will commence on January 18, When Sir Andrew Noble will deliver a Discourse on "Fifty Years of Explosives." Succeeding Discourses will probably be given by Mr. Charles Welch, Sir Almroth E. Wright, Prof. I. Gollancz, Mr. J. J. Lister, Mr. Dugald Clerk, Prof. D. J. Hamilton, Prof. J. J. Thomson, Prof. G. Lunge, and other gentlemen.

**The Tensile Strength of Copper-tin Alloys.**—E. S. Shepherd and G. B. Upton (*Journ. Phys. Chem.*, ix., 441).—This paper gives an account of an extended study of the mechanical properties of copper-tin alloys between 100 and 70 per cent of copper. In planning the experiments as well as in analysing the results, the copper-tin diagram was referred to. The test pieces were chill-cast in graphite moulds, and, in general, no machining was necessary to reduce them to the proper dimensions, which were 0·42 inch diameter and 3 inches length of cylinder. Numerous precautions had to be taken to insure reliable castings, particularly in the range from 94 to 87 per cent copper. As it was, some results had to be rejected. Tests on the ultimate tensile strength and per cent of elongation were carried out for interval of composition of 2 or 3 per cent for the most part. Tests were made on specimens as follows:—(1) Directly after casting; (2) after being heated for a week at 540°, and then quenched in water; (3) after being heated for a week at 400°, and then slowly cooled; and (4) after being brought to a medium red-heat and quenched. From 100 to 87 per cent copper the heat treatment had little effect on the ultimate strength of the alloy. From 87 to 76 per cent marked differences appear. Treatment (3) gives the weakest casting, while the other treatments gave increasing strength in the order (1), (2), (4). At 81 per cent the strength for treatment (3) was found to be 43,000 pounds per square inch, while for (4) it was found to be 63,000 pounds. The general result is therefore that annealing below red-heat tends to lessen the strength. The differences found between quenching from 540° after a week's heating and from red-heat after brief heating, are probably due to a coarser crystalline structure in the former. In the neighbourhood of 80 per cent copper the maximum strength is reached, after which the strength falls off abruptly, so that at 70 per cent it lies below 20,000 pounds, and is very uncertain, being almost zero in some cases. As regards ductility (per cent elongation) those pieces tested immediately after casting exhibit a slight maximum at 98 per cent. At this composition specimens subjected to other treatment exhibit a slightly higher ductility. Beyond this composition the test pieces annealed for a week at 400° and 540° show increasing ductility which reaches a maximum at about 87 per cent, the per cent elongation reaching 39 per cent for pieces annealed at 540°. Beyond 87 per cent the ductility falls off rapidly. Stress and strain curves were obtained for a number of compositions. Whatever the treatment, the curves rise regularly, and show no signs of a point of maximum load as do iron and steel.—*Journ. Am. Chem. Soc.*, xxviii., No. 10.

## MEETINGS FOR THE WEEK.

**Monday, 10th.**—Society of Arts, 8. (Cantor Lectures). "Artificial Fertilisers—their Nature and Functions," by A. D. Hall.

**Wednesday, 12th.**—Society of Arts, 8. "Fruit Growing and Protection of Birds," by C. H. Hooper.

**Thursday, 13th.**—Society of Arts, 4 30. "The Indian Mohammedans—Their Past, Present, and Future," by A. Yusuf Ali, M.A., &c.

**Friday, 14th.**—Physical, 7. Exhibition of Electrical, Optical, and other Physical Apparatus.

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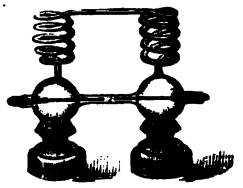

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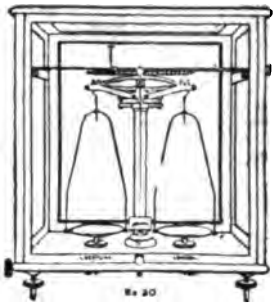

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## ON THE ORIGIN OF JET.

By PERCY E. SPIELMANN, A.R.C.S., A.I.C., B.Sc.(Hons.) Lond.

It may be of interest to reconsider the question of the origin of jet in the light of some new observations made during the year in connection with petroleum and natural gas. Although jet is considered by many to be wood, waterlogged and subsequently highly compressed, the details of its formation do not seem to be satisfactorily accounted for, except in a single case. Dr. Gothan, of Berlin (*a*), presents a highly probable theory to account for the formation of jet from wood, but expressly states that it is not necessarily accompanied by bitumen, since there is no trace of the latter in the jet-bearing strata of Bornholm. Now, in Yorkshire the jet is accompanied by bitumen, natural oil, and gas; so much so, that jet is thought by many to be a mineral product formed by the segregation of bitumen from the surrounding rock. It is therefore of interest and importance to consider first the origin of bitumen and of petroleum.

*Bitumen* occurs in all gradations—from a mobile dark petroleum to a brittle shining black asphalt, from a slowly-flowing bituminous sand to a massive asphalt rock of considerable hardness. The purest specimen is found in the Dead Sea (*b*), into which it flows in fluid condition from neighbouring hot springs. In Trinidad it forms a great lake, surrounded by luxurious vegetation. Some of its properties may be gathered from Tables I. and II. (*b*).

Table I.

| Locality. | Sp. gr. | Hardness. | M. p. |
|---|---|---|---|
| Bergteer of Lobsann, Lower Alsace .. .. | 1 | — | — |
| Bitumen from Trinidad . | 1·39—1·96 | 3 | 130—165° |
| Bitumen from Syria .. | 1·103 | 3—4 | 135° |
| Bitumen from Maracaibo | 1·091 | 3 | 130° |
| Bitumen from Barbados | 1·041 | 2 | 110° |

Nitrogen and oxygen may be present, as in the Dead Sea bitumen :—

| | | |
|---|---|---|
| C .. .. .. .. | 77·84 | per cent |
| H .. .. .. .. | 8·93 | „ |
| O .. .. .. .. | 11·54 | „ |
| N .. .. .. .. | 1·70 | „ |
| | 100·01 | |

Sulphur may be present to 10 per cent and mineral matter to 39·6 per cent (*b*). Out of twenty-seven analyses, thirteen have been found to contain oxygen, and eight sulphur (*b*). Although the flow of bitumen into the Dead Sea is increased after earthquakes, and is found mixed with sulphur (apparently confirming the Biblical account of the destruction of Sodom and Gomorrah), more recent examination has found no trace of vulcanity. On the contrary, the whole surrounding country seems to have been laid down in a quietly evaporating lake (*b*).

*Vegetable Origin.*—The bituminous dolomitic limestones of Lower Alsace contain a very large number of small fragments of wood, classified as coniferous wood (the very material that is considered to have given rise to jet). This limestone complex contains stalks, fruit, and leaves of *Chara Voltzi*, *Sabal major*, Cinnamonium, and Juglans, as well as Melania, Helix, Planorbis, and *Anthracotherium Alsaticum* (?). This is closely analogous to the Yorkshire jet rock, where wood, marine shells, and animal remains are found (*b*).

In Ragusa, Italy (*b*), occur rich fossil remains like stalks, apparently of the nature of plants, associated with which are sharks' teeth.

Peckham (*b*) considers the Trinidad asphalt to arise from the conversion of luxurious tropical vegetation to asphalt and then to bitumen by a low temperature distillation or fermentation.

On the whole the preponderance of evidence (both that cited above and that found in the literature of the subject) is in favour of a vegetable origin for bitumen, except in one case mentioned later on; so that even if some jet is formed from true bitumen (which is extremely unlikely, as will afterwards be seen) its origin still remains vegetable.

*Petroleum* always contains bitumen, just as bitumen always contains petroleum (*b*), and analyses show that both contain the same variable impurities, oxygen, nitrogen, and sulphur, while gold and arsenic are sometimes found in addition in petroleum (*d*).

Table II.—*Solubility.*

| | Water. | Dilute acids. | Caustic alkali. | Alcohol. | Ether. | Chloroform. | Petroleum. | Turpentine. |
|---|---|---|---|---|---|---|---|---|
| From Syria .. .. .. .. .. | Absolutely insoluble. | Absolutely insoluble. | Absolutely insoluble. | 21 per cent | 44 per cent | Completely soluble. | Completely soluble. | Completely soluble. |
| „ Trinidad .. .. .. .. | | | | 5 „ | 57 „ | | | |
| „ Maracaibo .. .. .. .. | | | | Little | Partly | | | |
| „ Barbados .. .. .. .. | | | | Partly | Partly | | | |
| „ Pechelbronn, Lower Alsace | | | | Partly | Almost complete | | | |

Most specimens are completely soluble in $CS_2$ and $C_6H_6$.

*Animal Origin.*—Only the bare suggestion by Jaccard (*c*) in 1890, that bitumen is an animal product, as compared with petroleum being of vegetable origin, has been put forward under this head.

*Mineral Origin.*—Thorpe (*h*) does not consider bitumen to be produced by purely chemical means, for in that case it is to be expected that it would be of the same composition in the various localities in which it is found. But this is not so, as may be gathered from the analyses. An average analysis would give the following result :—

| | | |
|---|---|---|
| C .. .. .. .. | 89·46 | per cent |
| H .. .. .. .. | 9·55 | „ |
| Ash.. .. .. .. | 1·09 | „ |
| | 100·10 | |

*Animal Origin.* — Zalozietki, 1897 (*c*), suggests that petroleum has resulted from the decomposition of albumenoid matter under the antiseptic action of the sea, since petroleum is connected with marine conditions. This is hardly correct, as petroleum is also found in peat bogs. Engler has also obtained an artificial petroleum by distilling animal fats at 10—20 atmospheres and 300—400° (*b*).

*Mineral Origin.*—Inasmuch as some of the members of the paraffin series have been obtained by the interaction of carbides and water, this mode of formation has been put forward for petroleum. This is possible, but, I think, very unlikely, owing to petroleum having been found recently to be optically active to polarised light.

*Vegetable Origin.*—Walden (*e*) has collected many measurements of optical activity of materials, animal and vegetable, connected with bitumen and petroleum, and finds the vegetable by far the largest in number and the more chemically probable. All the more so, as the animal substances are in general feebly active, while the vegetable resemble petroleum by being more strongly dextrorotary. This is strong evidence against the mineral theory of production of petroleum, since all substances which can be optically active, when produced by purely chemical means, are always inactive and have to undergo a subsequent process of separation into their active constituents; none of these can be thought to have occurred naturally in the case of petroleum.

Lesquereux (*b*) considers petroleum to have arisen from marine algæ; while the American experts suggest fucoids (*b*). Höfer (*b*) has found true fucoids in Pennsylvania and Carpathians, and in many other beds. From their experiments Krämer and Spilker (*b*) consider that algæ wax passes to ozokerite and then to petroleum, while Engler (*b*) suggests that animal fats decompose to bitumen and then petroleum, according to the conditions of pressure, temperature, and time. The unlikelihood of these latter theories will be seen shortly.

In all these suggestions one finds complicated bodies breaking down into more and more simple substances; but there is one where the opposite occurs. Strippelmann (*b*) contends that petroleum has hardened to asphalt. Many have found an asphalt-like substance from oxidising petroleum, also sulphur—which is often found in bitumens—polymerises petroleum, and Elchner (*b*) accounts for its presence by the reduction of local sulphates under great pressure. Clifford Richardson (*b*) has noticed that the hydrocarbons in bitumen have the general formula $C_nH_{2n}$, which can be easily polymerised at ordinary temperatures. One obtains also tarry matters when certain organic substances are treated with too violent reagents in the laboratory.

In spite of this, I think the gradual decomposition to simpler bodies to be the true direction of the change.

*Natural gas* is found both with or without accompanying petroleum, though its mode of origin must be very similar, if not actually identical.

In respect to the formation of bitumen and petroleum, one is tempted into assuming the agency of heat for an explanation by distillation (*d*, *e*), on account of the close resemblance to the distillation of coal giving oils and tar. But local examination of the deposits of bitumen and petroleum shows no trace of heat. The natural coke of Glasgow, Japan, and Sonora (Mexico), have no bitumen connected with them (*b*), and if petroleum wer a distillation product, one would expect to find some degree of fractionation; this, however, does not occur (*c*). At the risk of being thought fashionable, I would suggest that these phenomena are not unconnected with radium or some other radio-active substance. Quite recently an announcement has been made by Drs. Cady and Macfarland, of the University of Kansas, that considerable quantities of helium have been obtained from the natural gas of Dexter and in less quantities from other natural gas fields. The radium here may have caused the particular decomposition by supplying the slow and continuous heat necessary, or it may have induced chemical decay; perhaps both effects occurred simultaneously. Assuming for the moment that jet is the woody remains left after the bitumen and petroleum and gas have gone, a further decomposition may have gone in the jet, whereby decomposition was pushed to its uttermost (since the composition of jet closely resembles that of anthracite), and a little more gas and oil produced in the jet, which explains the fact that a specimen weighing 100 grs. of jet, yielded about 30·2 c.c. of gases at 100° (*g*). These consisted of:—

| | | |
|---|---|---|
| $CO_2$ | 10·93 | per cent |
| $C_4H_{10}$ | 86·90 | ,, |
| N | 2·17 | ,, |
| | 100·00 | |

Thus, the general trend of opinion—except that of Stripplemann—seems to be towards bitumen, petroleum, and natural gas being decomposition products of more complex bodies, very probably vegetable; and it is justifiable to assume that the more advanced and complex the decomposition the simpler are the substances produced.

Whether this decomposition has been brought about by the action of some radio-active substance, or by bacteria (like those which have been found fossil in coal), there seems little doubt that salts are closely connected with it, more especially aluminium salts. Natural gas and petroleum are very frequently associated with brine, and are probably generated from marine algæ and fucoids. The Dead Sea (*b*) contains aluminium salts, and the Dax salt (*k*) is close to a bitumen deposit. The shale above the Jet Rock in Yorkshire was formerly worked for the aluminium sulphate it contained; this is also obtained profitably from the coal measure shales near Manchester, and at Goole in Yorkshire, while aluminium mellitate (honey stone) occurs in peat bogs. It would thus seem that the aluminium sulphate has exerted the antiseptic influence known to be possessed by alum (*i*), thus retarding a bacteriological decomposition. Whether this salt could modify a decomposition caused by a radio-active substance cannot as yet be said.

Having shown that the three substances most closely connected with Yorkshire jet are highly probably vegetable in origin, it remains to consider the main subject—jet.

The best jet occurs in a particular horizon in the *serpentinous* zone of the Upper Lias Shale, but is never found in large pieces, the largest being 6 ft. 4 in. by 4 ft. 5 in. to 5 ft. 5 in. by 1 ft. 5 in., weighing 11·5 lbs. (*g*).

It varies considerably in quality, which is easily explicable on the assumption that the jet partially changed to bitumen and some petroleum, and that the latter evaporated, leaving a hard black deposit of inferior jet. So that one cannot say that this jet consists of bitumen or of wood—it is a solidified stage of the infinite gradations between true hard "wood jet" and "pure" bitumen.

That petroleum is present cannot be doubted on entering any of the old jet workings; the smell is strong, and inflammable gas has been met with in the old mines.

Bower (*k*) says:—"In one of the best specimens that has been found here, the mass in form and structure was that of a tree, with bark, knots, and roots, and in the curled portions of the roots, stones and soil conglomerated were imbedded." Such an observation could hardly be imaginary, and is a most definite example to be advanced against the "bitumen" theorists.

In my own possession is a specimen of Spanish jet (closely resembling the Whitby jet), which has a perfectly straight even line of pyrites along one face, which has apparently been laid bare by a blow. Mr. Arber, of the British Museum, has been kind enough to examine it for me; he writes:—"Yes; I think part of the Araucarian wood has been replaced by pyrites, which thus conforms to the original structure. Under the microscope one seems to see markings as of the pits of the woody elements. Such specimens are rare but not unknown." It is of interest also, as I have been assured by Mr. Newbitt, the curator of the Whitby Museum, and by a jet worker of thirty years' experience, that everything of an identifiable nature—fossil plants and shells, pyrites, &c.—in connection with jet, has been found *on* the jet and not *in* it.

In most specimens jet has been found to have lost almost all structure, but those in which it has been found have had their woody structure identified. And in some specimens where partial fossilisation has occurred, jet has formed that part of the wood unpreserved by the substituting materials.

Dr. Gothan (*a*), who, in the main, follows Prof. Seward, has made the following observations:—Wood in a sandy grey clay in Hermsdorf (Berlin) was allowed to dry in the open air. It was found to shrink greatly and twist spirally. It became very compact, being scarcely able to be cut with a knife, and under the microscope was found to have lost

almost all structure. This resulting material even developed certain zigzag lines, unexplained by Seward (*l*), but reproduced in fresh wood by Gothan by pressure, showing them to be the crumpled rings of growth of the original wood. Thus a substance well on the way towards resembling jet was formed even without pressure.

Those specimens of jet which have yielded traces of wood structure to the microscope have been found to be coniferous (Araucarian) (*l*), (*g*), (*m*). This wood also has given rise to the jet of Spain; it is found in the island of Bornholm and the wood associated with the bitumen of Lower Alsace is coniferous. A striking observation has recently been made by Mabery and Quayle (*n*) that Canadian petroleums probably contain terpenes.

It would seem from the manner in which jet occurs that coniferous wood has been washed from the land and become buried in the slowly depositing mud. A peculiar decomposition has set in which has been retarded or otherwise modified by the presence of salt water, and by the time the wood and oily matters have begun to break down, the mud had become sufficiently thick to form an impervious layer. As time went on and pressure increased, first from the weight of mud above, and then from the subsequent drying of the whole bed, the breakdown became more and more complete, helped by any heat which was probably generated in the decomposition. Not only was all air excluded, but strong reducing action occurred, causing the formation of a considerable amount of pyrites.

Substances sometimes resembling jet occur in lenticular masses in the Lower Lias clays of Dorsetshire, Gloucestershire, Leicestershire, and Shropshire (*o*); while in the Kimmeridge clay, also, jet-like substances are found (*p*).

But what happens, it may be asked, when vegetable matter is deposited in a sand instead of a mud? This can be seen in the Inferior Oolite of Yorkshire, the Estuarine Sandstones. Here plant remains, and wood have decomposed in a comparatively porous bed; air dissolved in water could reach the vegetable matter more easily, decomposition would be more rapid and thorough, all the more so as the conditions are here estuarine and not purely marine, so that the water would not be so salt, and so allow a still more rapid decomposition. More oils and gas would be formed than bitumen, and these would escape and leave no trace. Considering these conditions are half way between those controlling the formation of jet and of coal, one would expect these Estuarine products also to be between the two; this is exactly what has happened. The literature speaks indiscriminately of this substance as "coal" or "soft jet" (*q*), (*g*), (*i*); an experienced jet-worker at first pronounced it to be soft jet, and then wondered if it could be coal; and on trial the degrees of polish of the three substances, jet, Estuarine soft jet, and coal, were graded in the right direction.

When, however, decomposition takes place in the lagoons and swamps of the carboniferous period, or the peat bogs of to-day, the amount of petroleum is small and that of the gas considerable. But as soon as shale becomes associated with these decompositions, as in the oil shales of Scotland, petroleum and bitumen are at once formed, for the double reason of the imperviousness of the bed and the prolonged decomposition of the original substances.

The above suggestions as to the origin of jet and bitumen from coniferous wood will account for all the apparent difficulties felt concerning the specimens in the Whitby Museum, as well as explain why all fossils, &c., are on the jet and not in it; and, furthermore, why no mud sand, &c., is found in the jet, as would have happened if the latter had consisted of bitumen segregating process obviously different from the segregation of flint.

*References.*

(*a*) *Naturwissenschaftliche Wochenschrift*, 1906, v.
(*b*) Köhler, "Die Chemie und Technologie der Natürlichen und Künstlichen Asphalte," 1904.
(*c*) Klement, *Bulletin de la Société Belge de Géologie*, 1897.
(*d*) Crew, "Practical Treatise on Petroleum," 1887.
(*e*) *Chem. Zeit.*, 1906, xxx., 391, 1170.
(*f*) Quenstedt, see Köhler, *supra*.
(*g*) Fox-Strangeways, "Jurassic Rocks of Britain." Vol. I., Yorkshire, 1892.
(*h*) "Encyclopædia Britannica," article "Salt," 1886.
(*i*) Thorpe, "Dictionary of Applied Chemistry," 1890.
(*k*) Bower, *Journal of the Society of Arts*, 1873.
(*l*) Seward, "Jurassic Flora." Part II.
(*m*) Aber, Mr., Note from.
(*n*) *Am. Chem. Journ.*, 1906, xxxv., 404—432.
(*o*) Woodward, H. B., "Jurassic Rocks of Britain." Vol. III. Lias of England and Wales (excluding Yorkshire), 1893.
(*p*) Tate and Blake, "Yorkshire Lias," 1876.
(*q*) "Encyclopædia Britannica," articles, "Jet," 1880; "Mineralogy," 1878.

## THE USE OF THE ROTATING CATHODE FOR THE ESTIMATION OF CADMIUM TAKEN AS THE SULPHATE.*

By CHARLES P. FLORA.

(Concluded from p. 276).

### VI. *In Solutions containing Oxalates.*

Much work was expended upon the oxalate method, but in spite of this, a satisfactory deposit could not be obtained. When ammonium oxalate was present, even in small amounts, the depoiit was very spongy; while the use of sodium oxalate alone, when carried down even to the smallest excess possible to give a soluble double oxalate, gave results much too high. The dissolving of the precipitated oxalates in various reagents furnished no solution to the problem.

The results in Table VI. will show the scope of the work done. Of these, Nos. 1, 2, 3, 6, 8, 9, 14, 15, 17, and 18 gave very spongy precipitates, while No. 7 was so spongy that it could not be satisfactorily dried, and so was not weighed. In experiments numbered 4, 9, 10, 14, 15, and 18 the cadmium was not all precipitated in the time allowed. In No. 10, also, the precipitate was non-adherent. In No. 16 the oxalate was precipitated and was not broken up by the current.

### VII. *In Solutions containing Urea, &c.*

Balachowsky (*Comptes Rendus*, 1900, cxxxi., 385) obtained good results by the electrolysis of solutions containing, in addition to cadmium salts, urea and various aldehydes. These solutions were found to offer no difficulties with the rotating cathode, when cadmium sulphate is taken, as may be seen from Table VII. The deposits were grey, compact, and quickly dried. The solution was diluted to about 60 c.c. or 70 c.c., and the best current potential was found to be that given by six storage cells connected in series—approximately 11·8 volts.

Since the conductivity of the solutions containing urea and the aldehydes is comparatively low, the effect of adding electrolytes was tried. The rate of deposition was very much increased, but the precipitated metal showed such tendency towards sponginess that this procedure is not to be highly recommended. The tests tried are given in Table VIII.

### VIII. *In Solutions containing Formates.*

The use of the solutions containing potassium formate and a slight excess of formic acid has been recommended (Warwick, *Zeit. Anorg. Chem.*, 1892, i., 285; Avery and Dales, *Journ. Am. Chem. Soc.*, 1897, xix., 380), but I was unable to adopt this method to the rotating cathode.

* Contributions from the Kent Chemical Laboratory of Yale University. From the *American Journal of Science*, xx., p. 268.

TABLE VI.

| No. | Cd taken. Grm. | Ammonium oxalate. Grm. | Potassium oxalate. Grm. | Solvent. | Current = Ampères. | N.D.$_{100}$. Ampères. | E.M.F. Volts. | Time. Mins. | Cd found. Grm. | Error. Grm. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 0·1491 | Excess | None | None | 3·0 | 9·0 | 12 | ? | 0·1558 | +0·0067 |
| 2. | 0·1491 | Slight excess | None | None | 2·5 | 7·5 | 12 | 30 | 0·1506 | +0·0015 |
| 3. | 0·1491 | 2·0 | 0·5 | None | 2·0—2·5 | 6·0—7·5 | 8 | 25 | 0·1531 | +0·0040 |
| 4. | 0·1491 | None | 0·5 | 15 drops $H_2SO_4$ | 2·5 | 7·5 | 8 | 30 | 0·1476 | −0·0015 |
| 5. | 0·1491 | None | 8·0 | None | 2·0 | 6·0 | 6·2 | 20 | 0·1507 | +0·0016 |
| 6. | 0·1118 | 4·0 | None | None | 1·5 | 4·5 | 6·1 | 20 | 0·1272 | +0·0154 |
| 7. | ? | None | 5·0 | Few c.c. $NH_4OH_3$ | 2·0—3·5 | 6·0—10·5 | 6—8 | 18 | ? | ? |
| 8. | 0·1118 | None | 5·0 | None | 1·5 | 4·5 | 6·0 | 15 | 0·1129 | +0·0011 |
| 9. | 0·1019 | None | 4·0 | None | 2·0—3·0 | 6·0—9·0 | 8 | 20 | 0·0995 | −0·0024 |
| 10. | 0·1019 | None | 6·0 | None | 0·5—1·5 | 1·5—4·5 | 4—6 | 35 | 0·0982 | −0·0037 |
| 11. | 0·1019 | None | 5·0 | None | 1·0 | 3·0 | 5·5 | 55 | 0·1033 | +0·0014 |
| 12. | 0·1019 | None | 7·0 | None | 0·5 | 1·5 | 4 | 55 | 0·1030 | +0·0011 |
| 13. | 0·1223 | 2·0 | 8·0 | None | 0·1—0·15 | 0·3—0·45 | 4 | 60 | 0·1236 | +0·0013 |
| 14. | 0·1223 | 2·0 | 8·0 | None | 0·02—0·10 | 0·06—0·3 | 4 | 76 | 0·1229 | +0·0006 |
| | | KOH. | $H_2SO_4$ (dil.). | Oxalic acid. | | | | | | |
| 15. | 0·1223 | 1·0 | 10 c.c. | 5 grms. | 3·0 | 9·0 | 8 | 40 | 0·0876 | −0·0347 |
| 16. | 0·1223 | 0·25 | — | 10 ,, | — | — | — | — | — | — |
| 17. | 0·1019 | — | — | 1 ,, | 1—2 | 3—6 | 8 | 35 | 0·1033 | +0·0014 |
| 18. | 0·1019 | — | — | 3·5 ,, | 3 | 9 | 8 | 60 | 0·1018 | −0·0001 |

TABLE VII.

| No. | Cd take Grm. | Current = Ampères. | N.D.$_{100}$. Ampères. | Time. Minutes. | Cd found. Grm. | Error Grm. |
|---|---|---|---|---|---|---|
| | | | *Series* A.—Urea, 3 grms. | | | |
| 1. | 0·1019 | 0·25—0·5 | 0·75—1·5 | 35 | 0·1018 | −0·0001 |
| 2. | 0·1223 | 0·2 | 0·6 | 35 | 0·1223 | 0·0000 |
| 3. | 0·1223 | 0·25—0·5 | 0·75—1·5 | 30 | 0·1230 | +0·0007 |
| | | | *Series* B.—Formalin, 2 c.c. | | | |
| 1. | 0·1019 | 0·1—1·0 | 0·3—3·0 | 30 | 0·1018 | −0·0001 |
| 2. | 0·1223 | 0·2—1·0 | 0·6—3·0 | 30 | 0·1224 | +0·0001 |
| 3. | 0·1223 | 0·2—1·0 | 0·6—3·0 | 30 | 0·1225 | +0·0002 |
| | | | *Series* C.—Acetaldehyde, 2 c.c. | | | |
| 1. | 0·1019 | 0·1—0·8 | 0·3—2·4 | 35 | 0·1022 | +0·0003 |
| 2. | 0·1223 | 0·1—0·8 | 0·3—2·4 | 30 | 0·1228 | +0·0005 |
| 3. | 0·1223 | 0·1—0·8 | 0·3—2·4 | 30 | 0·1222 | −0·0001 |

TABLE VIII.

| No. | Cd taken. Grm. | Electrolyte. | Cd found. Grm. | Error. Grm. | Notes. |
|---|---|---|---|---|---|
| | | *Series* A.—Urea, 3 grms.; Time, twenty minutes; E.M.F., 7·8 volts; Current read, 0·5 ampère; N.D.$_{100}$, 1·5 ampères. | | | |
| 1. | 0·1019 | 0·5 grm. $K_2SO_4$ | 0·1031 | +0·0022 | Spongy. |
| 2. | 0·1019 | 0·5 ,, | 0·1031 | +0·0022 | Spongy. |
| 3. | 0·1019 | 5 drops $H_2SO_4$ (1 : 4) | 0·1023 | +0·0004 | Good precipitate. |
| 4. | 0·1019 | 5 ,, ,, | 0·1027 | +0·0008 | Slightly spongy. |
| 5. | 0·1019 | 8 ,, ,, | 0·1027 | +0·0008 | Slightly spongy. |

*Series* B.—Formaldehyde (formalin), 2·5 c.c.; Time, twenty minutes; E.M.F., 7·9 volts; Current started at 0·5 ampère and rose to 1·0 ampère at the end of the process (N.D.$_{100}$ = 1·5—3·0 ampères). In each case the precipitate was good. Ten drops of dilute sulphuric acid were added to increase the conductivity of the solution.

| | | | |
|---|---|---|---|
| 1. | 0·1019 | 0·1020 | +0·0001 |
| 2. | 0·1019 | 0·1019 | 0·0000 |

TABLE IX.

| No. | Cd taken. Grm. | $KCHO_3$, sat. sol. C.c. | HOCHO. Grm. | Current = Ampères. | N.D.$_{100}$. Ampères. | E.M.F. Volts. | Time. Minutes. | Cd found. Grm. | Error. Grm. |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 0·1019 | 2 | — | 1·0—2·0 | 3—6 | 8 | 17 | Not weighed; precipitate blistered and dropped off. | |
| 2. | 0·1223 | 0·5 | — | 0·4 | 1·2 | 8 | — | | |
| 3. | 0·1223 | 0·5 | — | 0·4 | 1·2 | 8 | — | | |
| 4. | 0·1223 | 0·5 | — | 0·4 | 1·2 | 8 | — | | |
| 5. | 0·1223 | — | 15 drops | 0·25—0·8 | 0·75—2·4 | 12 | 25 | 0·1228 | +0·0005 |
| 6. | 0·1223 | — | 15 ,, | 0·25—0·8 | 0·75—2·4 | 8 | 25 | 0·1212 | −0·0010 |
| 7. | 0·1223 | — | 21 ,, | 0·5—1·5 | 1·5—4·5 | 12—16 | 35 | 0·1202 | −0·0021 |
| 8. | 0·1019 | — | 1·5 c.c. | 0·5—1·0 | 1·5—3·0 | 12 | 60 | 0·1022 | +0·0003 |
| 9. | 0·1223 | — | 1·5 ,, | 0·4—1·0 | 1·2—3·0 | 12 | 55 | 0·1218 | −0·0005 |

TABLE X.

| No: | Cd taken. Grm. | Tartaric acid. Grm. | Current = Ampères. | N.D.100. Ampères | E.M.F. Volts. | Time. Minutes. | Cd found. Grm. | Error. Grm. |
|---|---|---|---|---|---|---|---|---|
| 1. | 0·1223 | 3 | 0·5—1·0 | 1·5—3·0 | 8 | 20 | 0·1212 | − 0·0011 |
| 2. | 0·1223 | 2 | 0·5 | 1·5 | 8 | 30 | 0·1216 | − 0·0007 |
| 3. | 0·1223 | 2 | 0·5 | 1·5 | 8 | 50 | 0·1215 | − 0·0008 |
| 4. | 0·1019 | 3 | 1·5 | 4·5 | 11·8 | 18 | 0·1022 | + 0·0003 |

When potassium formate was present in even the smallest amounts the precipitate was spongy, and non-adherent. From solutions containing formic acid alone, however, the metal is deposited in a satisfactory form, but only after long passage of the current. The results given in Table IX. will show the limit of applicability of the process, experiments numbered 8 and 9 seeming to represent the most desirable conditions.

In the experiments numbered 5, 6, and 7, the cadmium was not all precipitated in the time indicated, as was shown by testing the solution with hydrogen sulphide.

### IX. *In Solutions containing Tartrates.*

Solutions containing ammonium tartrate were also tried, but failed to give satisfactory deposits, the deposit in each case being spongy. If the solution contain only tartaric acid, however, in place of its salts, fairly satisfactory results may be obtained, as shown by Table X.

Tests with hydrogen sulphide showed that the cadmium was not all precipitated in the tests numbered 1, 2, and 3, which were performed at a dilution of 70 c.c.; Experiment 4 was performed at dilution of 50 c.c. It will be noted that, as in the sulphate process, the last traces of cadmium are thrown out of the higher state of dilution only with extreme difficulty.

ON SOME

## POINTS OF CHEMICAL PHILOSOPHY INVOLVED IN THE DISCOVERY OF RADIUM AND THE PROPERTIES OF ITS COMBINATIONS.*

By HENRY WILDE, D.Sc., D.C.L., F.R.S.

DR. WILDE referred to the profound interest created by the discovery of the new element radium, as evidenced in various scientific publications and in magazine articles on "The Revelations of Radium," "The Miracle of Radium," and other titles equally striking. Although the new element has not yet been isolated, its spectrum and chemical reactions leave no room for doubt of its existence. He discussed the series-position, atomic weight, and specific gravity of radium as prevised in his former papers published some years before its discovery, and gave reasons for retaining the values then assigned to them in his tables. It was pointed out as a singular circumstance that, notwithstanding the wonderful powers attributed to radium, no chemist has yet seen or handled the element in its pure metallic state, in order that its general properties might be ascertained. Reference was made to the undisputed fact that all the elements of the series containing radium, which exhibit the property of phosphorescence and radio-activity when in combination with sulphur or other electro-negative elements, behave like ordinary substances when in the elementary metallic state. By strict analogy metallic radium would, in like manner, be divested of all the extraordinary properties which have been attributed to it and opened out so wide a field for ultra-scientific hypotheses. Moreover, as the phosphorescent properties of the radium series only become manifest when in combination with the chlorine and oxygen series of elements, it may with good reason be maintained that the extraordinary properties attributed to radium really belong to the negative elements with which it enters into combination. A number of instances were adduced by Dr. Wilde of phosphorescence and radio-activity in inorganic and organic nature in support of this view. The transformation of the radium bromide emanation into helium by Sir W. Ramsay and Mr. Soddy has been fully confirmed by Himstedt and Meyer, Giesel, and others. As no suggestion has been made that elementary bromine was set free during the transformation, chemists are confronted with the fact that both bromine and radium are simultaneously transformed into helium. The author expressed his satisfaction on the confirmation of the views and previsions advanced in his former papers on the origin of elementary substances, especially in connection with the transformation of radium into helium, and the places assigned to these elements in his tables previous to their discovery. The transformation of radium combinations into helium clearly demonstrates that the "constitution of matter" is not necessarily atomic in the sense generally accepted by chemists. Dr. Wilde declared his conviction that the ultimate constitution of all substances, including the universal medium (ether) that fills infinite space, is absolutely inscrutable to human understanding. This conviction he shares with that distinguished cultivator of natural knowledge, Sir W. R. Grove, who in his epoch-marking book on the "Correlation of Physical Forces" refers to "the harm done by attempting hypothetically to dissect matter, and to discuss the shapes, sizes, and numbers of atoms, and their atmospheres of heat and electricity." Not the least valuable result of the study of mental philosophy is the conscious realisation of its limitations.

* Read before the Manchester Literary and Philosophical Society, November 27th, 1906.

## HYDROXYLAMINE-αβ-DISULPHONATES.*

STRUCTURAL ISOMERIDES OF HYDROXIMINO-SULPHATES OR HYDROXYLAMINE-ββ-DISULPHONATES.

By TAMEMASA HAGA,
Professor of Chemistry, Imperial University, Tokyo.

(Concluded from p. 279).

### *Decomposition of the Potassium Salt by Potassium Hydroxide.*

WHETHER potassium hydroxylamine-αβ-disulphonate is decomposed solely into acid-sulphate, aminemonosulphonate, and nitrogen, when heated with a concentrated solution of potassium hydroxide (see *ante*), or whether it is, to a small extent, decomposed into nitrous oxide, according to the equation—

$$4(SO_3K)ONH(SO_3K) + 6KOH = 6(SO_3K)OK + 2NH_2(SO_3K) + N_2O + 3H_2O,$$

is not certain. It is experimentally difficult to get sufficiently trustworthy qualitative results. Even qualitatively, there is the uncertainty to deal with, as to the entire absence of nitrous oxide from the nitrogen obtained. In these experiments, the gas given off extinguished a flaming match and refused when mixed with hydrogen to explode by the electric spark. The occasional production of some nitrous oxide is, perhaps, to be inferred from the ratio of the quantity of sulphur as sulphate to that as aminemonosulphonate found in one experiment, although its production was not thus indicated in another experiment. But,

* *Journal of the College of Science, Imperial University, Tokyo, Japan*, xxi., Article 6.

as accuracy in determining this ratio is affected by the fact that the analytic separation of sulphate from aminemonosulphonate is only approximate (*Journ. Coll. of Sci., Japan*, ix., 281; xiii., 503), the production of any nitrous oxide still remains uncertain. Another difficulty in the quantitative examination of the decomposition is that the decomposition is far from complete after several hours heating at 120°. The presence of still undecomposed salt is shown by the production of hydroxylamine when the products are hydrolysed and by the fact that a temperature of 180°, instead of 150°, is necessary to ensure complete hydrolysis of the products. No ammonia is generated, the only products being those already mentioned.

When the gases were to be collected the salt was heated with one and a-half to twice its weight of potassium hydroxide and about four times its weight of water for six hours at 100° or for four hours at 120° in a tube retort connected with a Sprengel pump. Needless to say, explosive ebullition and corrosion of the hard glass tube (rendering it opaque) had to be encountered as difficulties. When the gases were to be allowed to escape, the mixture was heated in a platinum dish on the water-bath. For analysis, the residue in either case was made faintly acid to phenolphthalein by nitric acid, and sulphate then precipitated by barium nitrate. The thoroughly washed precipitate was purified in the usual way by fusion with an alkali carbonate before weighing. The aminesulphonate was precipitated by mercuric nitrate, the mercuric salt was hydrolysed, and the sulphuric acid and sometimes the ammonia resulting were determined. The filtrate from the mercury precipitate always showed the presence of hydroxylamine-$\alpha\beta$-disulphonate,

In an experiment with 1·057 grm. of salt, the sulphur found as sulphate was 66·82 per cent, and that as aminesulphonate 15·73 per cent of the total sulphur, leaving 17·45 to be accounted for as undecomposed salt. Of the total nitrogen, 29·64 per cent were got as ammonia from the aminesulphonate, and 48·89 per cent as gas (27·85 c.c. moist nitrogen at 18° and 639·8 m.m. = 0·002692), leaving 21·47 per cent as undecomposed salt. The difference between 17·45 and 21·47, perhaps due to slight leakage of air into the apparatus during the six hours heating, is not at all so significant as it is made to appear by the way of stating the results, the total percentage of nitrogen in the salt being only 5·2 per cent. On the assumption that 65 per cent of the salt decomposed so as to give nitrogen (see *ante*) and 16·7 so as to give nitrous oxide (see above), and that 18·3 per cent remained undecomposed, the numbers should be sulphur as sulphate, 66·68, and as aminesulphonate, 15·01 per cent, nitrogen as aminesulphonate, 30·02, and as free nitrogen and nitrous oxide, 48·30 per cent of the total.

In another experiment, in which 0·9792 salt was heated at 120—125° for four hours, the indications of the analysis were that 19·9 per cent of the salt had resisted decomposition and that no nitrous oxide had been formed. The numbers obtained were 66·69 per cent sulphur as sulphate, instead of 66·75 calculated; and 12·94 sulphur as aminesulphonate, instead of 13·35 calculated, Some of the gas was lost, so that the distribution of the nitrogen could not be sufficiently tested.

In an experiment in which the salt was heated at 100° with potassium hydroxide for many hours in a platinum dish with occasional renewal of the water, the sulphur of the sulphate produced amounted to 77·24 per cent of the total. Decomposition of all the salt with production of nitrogen would give 83·33 per cent.

### *Products of Hydrolysis of Hydroxylamine-$\alpha\beta$-disulphonates.*

Potassium hydroxylaminetrisulphonate, which for these experiments could be substituted for the disulphonate, the product of its hydrolysis, was moistened with dilute sulphuric acid and heated in a vacuum at 100', in order to effect its hydrolysis and collect the gas evolved. The gas had no action upon ferrous sulphate, and was not appreciably soluble in alcohol. It therefore contained no nitric oxide and apparently no nitrous oxide.

Sodium hydroxylaminetrisulphonate in solution in water, just acid with sulphuric acid, was left for several days to slowly hydrolyse, principally to the disulphonate. It was then kept for fifty minutes at 95°, during which brisk effervescence of nitrogen went on, slackening only when near the end of the time. The acidity was then found to be somewhat more than that indicated by either of the following equations, the one for hydroxylamine sulphate, the other for the unknown hydroxylamine-$\alpha$-monosulphonate:—

$$(SO_3Na)ONH(SO_3Na) \times 2H_2O = (SO_3H)ONH_3OH + Na_2SO_4$$

$$(SO_3Na)ONH(SO_3Na) + H_2O = (SO_3Na)ONH_2 + NaHSO_4$$

The additional acidity and the escape of nitrogen indicated the occurrence, to some extent, of the decomposition expressed by:—

$$3(SO_3Na)ONH(SO_3Na) + 3H_2O = N_2 + NH_4HSO_4 + 4NaHSO_4 + Na_2SO_4$$

The solution gave only a moderate reaction for hydroxylamine with the copper test, and on evaporation, with or without previous neutralisation, gave nothing but sodium and ammonium sulphates.

In presence of sufficient hydrochloric acid, say, one volume of the fuming solution to ten volumes of solution of the salt, the production during hydrolysis of nitrogen and ammonia is very slight. The disodium salt in such a solution, after it had been kept heated for five minutes or so by immersing the vessel in boiling water, gave evidence, on titrating with iodine, of the presence of hydroxylamine equivalent to 95 per cent of the salt. In another experiment, in which the solution was left standing for 50 days at the ordinary temperature, 76·5 per cent of the salt had then yielded hydroxylamine.

In another similar experiment, the solution after standing in the cold was also evaporated in the cold under reduced pressure, until the salts crystallised out, and still nothing else but sodium and hydroxylamine sulphates, except a very little ammonium sulphate, was obtained.

In other experiments, using in these cases the dipotassium salt, the hydrolysis was allowed to go on either in the cold or at 60°, and portions of the solution occasionally tested to see whether some indication could be got of the production of hydroxylamine-$\alpha$-monosulphonate at any stage of the hydrolysis. In making the test, the acid sulphate was removed by barium chloride and the solution then tested with iodine in presence of sodium acid-carbonate. Since the consumption of the iodine caused no precipitation of barium sulphate, evidence was thus obtained that the reducing substance was hydroxylamine only and not its sulphonate derivative. Ultimately, by evaporating the solution, when sufficiently hydrolysed, hydroxylamine sulphate was crystallised out, along with the sodium sulphate.

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**Separation of Chlorine and Bromine in Acid Solution with Hydrogen Peroxide.**—P. Jannasch.—The quantitative separation of bromine and chlorine by means of hydrogen peroxide in solutions containing sulphuric acid is dependent upon the concentration of the acid. If the solution contains too little acid the bromine is only partially isolated, and in very dilute solutions the reaction practically does not occur. If, however, much sulphuric acid is present the bromine separates out even in the cold. It is best to heat the mixture of halogens in a current of carbon dioxide. The method is then very accurate, although the bromine found was always a trifle low, owing to slight defects in the arrangement of the apparatus, mechanical loss, &c. No trace of bromide ever remained behind with the chloride.—*Berichte*, xxxix., No. 14.

# PROCEEDINGS OF SOCIETIES.

## PHYSICAL SOCIETY.

*Ordinary Meeting, November 23rd, 1906.*

Prof. J. PERRY, F.R.S., President, in the Chair.

A PAPER on the "*Electric Radiation from Bent Antennæ*" was read by Dr. J. A. FLEMING, F.R.S.

The author referred at the outset to a paper read to the Royal Society in March last by Mr. Marconi on "Methods whereby Electric Waves may be mainly confined to certain directions," and to his own note read at the same time and published in revised form somewhat later on, "The Theory of Directive Antennæ or Unsymmetrical Hertzian Oscillators" (*Proc. Roy. Soc.*, 1906, A, vol. lxxviii., p. 1), Mr. Marconi showed that if a vertical radiator earthed at the lower end was bent over so that a short part was vertical and a much longer part horizontal, it radiated less vigorously in the direction in which the free or insulated end pointed than in the opposite direction. He (Dr. Fleming) had shown mathematically that this difference depended upon the ratio of the wave-length of the radiated wave to the distance between the radiator and receiver, as well as upon the ratio of the lengths of the horizontal and vertical parts of the antenna. Mr. Marconi had operated with waves of about 150 metres wave-length, but it appeared desirable to test the theory and the expressions given by the author for the electric and magnetic force round such a bent antenna by making experiments with shorter wave-lengths and correspondingly shorter distances. The paper is accordingly occupied with an account of experiments made during the past summer in the quadrangle of University College, London, with radiating antennæ consisting of wires bent in various ways, which have the property of radiating electric waves more strongly in some directions than others. The receiving arrangement used was first described. It consisted of a thermoelectric oscillation-detector contained in a double test-tube like a Dewar vacuum-vessel as used for collecting liquid gases. Four copper strips pass down the inner tube, and platinum wires soldered to them are sealed through the glass. One pair of these are connected by a fine constantan wire about 0·02 m.m. diameter, and the other pair are connected by a tellurium-bismuth thermojunction which just touches the centre of the fine wire. A high vacuum is made in the space between the test-tubes. If electric oscillations are sent through the constantan wire and a suitable galvanometer connected to the thermojunction, this receiver affords a means of measuring the root-mean-square value of the oscillations induced in any receiving antenna when the fine wire is is inserted between the antenna and the earth. The receiver used gave deflections almost exactly proportional to the square of the current passing through the fine wire. This receiver was inserted between an earth-plate and a vertical receiving-antenna consisting of a double copper wire 20 feet high with a small capacity-plate at the top. The transmitting antenna consisted of a similar wire and plate so supported that it could be bent over at any required height above the ground and the horizontal part swivelled round into various azimuths. Readings were taken of the current in the receiving antenna, and plotted out as polar curves corresponding to the various directions of the free end of the transmitter. Curves are given in the paper showing the form of the polar curve when the 20-foot transmitting wire is all vertical or bent over at a height of 1 foot, 2 feet, 3 feet, 4 feet, 5 feet, and 10 feet respectively from the ground, and these show that the intensity of radiation in various azimuths for constant distance between receiver and transmitter becomes more unequal as the ratio of horizontal to vertical part of the transmitter increases. Also all the polar curves show a minimum radius vector or radiation corresponding to a direction of the free end of the transmitter, such that it makes an angle of 70° to 75° with the line joining the earthed points of the transmitter and receiver. This is shown to be entirely in accordance with the theory given by the author. For the case of a certain ideal small bent antenna partly vertical, partly horizontal, the magnetic force H at any distance $r$ from the transmitter when sending out waves of length $\lambda = 2\pi/m$ taken in a direction such that $r$ makes an angle $\theta$ with the direction in which the horizontal portion of the antenna points is given by the following expression :—

$$H = 1/r^2 \left\{ (\phi v m^2 r^2)^2 + (\phi v m r - \frac{M}{2} m^2 r^2 \cos\theta)^2 \right\}^{\frac{1}{2}},$$

H being the magnetic force at the end of the radius vector perpendicular to it and also parallel to the earth's surface. $\phi$ in the above equation is the electric moment of the antenna and M its magnetic moment.

This equation shows that H has a minimum value when—

$$\cos\theta = \frac{2\phi v}{M} \cdot \frac{1}{mr},$$

and it is shown in the Paper that for the cases considered—

$$\cos\theta = 0{\cdot}375 \times \lambda/r.$$

The experiments were all made at distances $r$ such that $\lambda$ $r$ was nearly equal to 0·72. and hence the minimum value should occur when—

$$\cos\theta = 0{\cdot}27 \text{ or } \theta = 74^\circ\ 20',$$

which is not far from 75° as actually found by observation. For the family of curves given show that the minimum radii occur at 105° reckoned from the direction opposite to that in which the free end points. It is shown that the form of the polar curve observed for the same sending antenna, but with different distances between sender and receivsr, varies as it should do by theory. A large number of forms of antenna were examined, some consisting of a single bent wire and others of a vertical wire with a lateral attachment, and the polar curves are given showing the field at constant distance but in various azimuths round these transmitters. It is shown that if a double bent antenna was used consisting of a semirectangle of wire with the ends of the two vertical parts bedded in the earth, the polar curve round it would be a simple Cosine Curve or figure-of-8. In the case of a simple vertical sending wire the polar curve is of course a circle. If a vertical radiating wire is therefore bent over so as to have part of its length vertical and part horizontal, its polar curve is of an intermediate form and is a sort of deformed oval or figure-of-8 curve with unequal loops always having a minimum radius vector at nearly the same vectorial angle of 70° or 75° reckoned from the longest diameter. The Paper concludes with an explanation of similar effects observed by Mr. Marconi in the case of bent receiving antennæ; and it is shown that these effects cannot be explained without admitting three sources of electromotive force in the bent receiving-antennæ—(*i*) that due to the magnetic force of the incident wave, (*ii*) that due to the electric force, and (*iii*) an electromotive force due to the periodic insertion and removal of lines of magnetic force from the nearly closed loop formed by the bent antennæ. Generally speaking, all the directive effects found to be associated with bent transmitting and receiving antennæ, as used for wireless telegraphy, are explicable on the basis of the theory expounded by the author in the above-mentioned mathematical paper. The important bearing of these facts and observations on the problem of directive electric wave telegraphy was also pointed out.

A paper was read by Dr. CHREE entitled "*Auroral and Sun-spot Frequencies Contrasted.*"

In several recent papers the author has investigated the relationships between certain phenomena of Terrestrial Magnetism and Sun-spot Frequency. The present paper makes similar comparisons between Sun-spot frequency and the frequency of Auroras. The sun-spot data utilised are from the big table of Wolf and Wolfer, covering the long period 1749 to 1901, and containing mean values for

every month of that period. Mean values have been calculated from this table for each month of the year, employing the whole period and certain portions of it, and also dealing separately with years of many and years of few sun-spots. One object was to see whether there was appreciable variation in the mean sun-spot frequencies thus obtained for individual months of the year. The differences between the means for individual months proved to be by no means negligible when calculated from 33 consecutive years, or from groups of 33 or 39 years selected as representing sun-spot maximum and minimum. The uncertainties thus introduced into enquiries as to the variation throughout the year in the relationships between sun-spot frequency and terrestrial phenomena are pointed out.

A comparison is instituted between mean sun-spot frequencies and mean auroral frequencies calculated for the same group of years. The auroral frequencies are taken from two sources—viz., Catalog der in Norwegen bis Juni 1878 beobachteten Nordlichter zusammengestellt von Sophus Tromholt, herausgegeben von J. Fr. Schroeter; and Joseph Lovering's "On the Periodicity of the Aurora Borealis."

During the long periods dealt with, there seemed strong reason to believe that variation occurred in the unit of auroral frequency. To eliminate such uncertainties as far as possible, a period, say, poor in sun-spots is contrasted with two equal periods rich in sun-spots, one preceding and the other following it. An investigation is made as to whether the annual variation of auroral frequency is the same in years of many as in years of few sun-spots. The evidence is not perhaps altogether decisive, but so far as it goes it points to the conclusion that, *relatively* considered, the annual variation is more pronounced—*i.e.*, the range a larger fraction of the mean value when sun-spots are few than when they are numerous. A similar phenomenon has been described by the author in the case of magnetic storms at Greenwich.

The parallelism between sun-spot and auroral frequencies is on the whole fairly similar, whether the auroral frequencies are derived from Lovering's General Catalogue or from the Tromholt-Schroeter data for Scandinavia as a whole. There seems, however, to be a somewhat conspicuous difference between the variation in the annual auroral frequencies derived from the South and the North of Scandinavia; and data which Danish observers have published for Greenland seem to indicate an inversion even of the relationship with sun-spots observed elsewhere. At first sight, the much greater length of time for which records exist suggests that Aurora lends itself more readily than Terrestrial Magnetism to a comparison with sun-spots; but this seems to be more than neutralised by the heterogeneous nature of auroral data,

Dr. J. A. Harker asked if in making calculations upon sun-spot frequencies any account was taken of the different sizes of spots.

Dr. Chree said the Astronomer Royal measured the areas of the spots, but Wolf used a "relative number" depending upon the total number of spots observed and upon the number of groups and isolated spots. The two methods of estimating the sun-spot frequency agreed well.

A paper was read by Dr. R. S. Willows "*On the Electrical Resistance of Alloys.*"

Lord Rayleigh has given a theory intended to account for the high resistance of alloys compared with that of the constituent metals (*Nature*, June, 1896, and Collected Papers, vol. iv., p. 232). According to this theory, when a current is sent through an alloy it sets up a series of Peltier effects at the junctions of the dissimilar metals, and hence also a back E.M.F. Since these effects are proportional to the current, they are indistinguishable from a resistance under ordinary conditions. It is this spurious resistance that may account for the difference in behaviour of an alloy and a pure metal. The author attempts to put this in evidence by measuring the resistance of an alloy with direct and also alternating currents. At the instant of reversal of the latter the back E.M.F., will assist the external E.M.F., and hence more current will pass, *i.e.*, the resistance will apparently be reduced. A bridge method is used, the frequency varying between 10—980 per second. No spurious resistance could be detected. If it were present its temperature coefficient would probably differ from that of a pure resistance. The method is therefore used between temperatures 100° C. and that of liquid air, but again with negative results. A minimum accuracy of 0·02 per cent is attained.

Prof. J. A. Fleming expressed his interest in the paper and said Lord Rayleigh's theory was ingenious, but it seemed to him that it pre-supposed a coarseness of structure in the alloy. An alloy was probably a substance of the nature of a solution with a fine structure, and it was difficult to see how thermoelectric E.M.F.s could be brought into play without discontinuity of material. Considering an electric current as a passage of electrons, Prof. Fleming pointed out that some of the electrons would pass through the spaces between the molecules in the material and others would impinge against the molecules themselves or the molecular aggregates. The latter would set up perturbations which would produce heat and corresponding electric resistance. If an alloy were supposed to consist of molecular aggregates while a pure metal consisted of molecules, more electrons would pass through material in the latter case than in the former. This would produce a greater quantity of heat, and correspond to a higher resistance in the case of the alloy.

Mr. A. Campbell said that shortly after Lord Rayleigh advanced his theory he made some experiments to try to detect if alloys showed changes of resistance when tested with alternating and direct currents. The alloy selected was ferro-nickel, as it was expected that this would show the effect strongly, as the constituents give a strong thermoelectric E.M.F. A current was sent through a long ferro-nickel wire doubled back on itself, and this current was measured by a Kelvin balance, while the voltage on the ends of the wire was measured by a Kelvin electrostatic voltmeter (reading to 1 in 1000). No difference could be detected between the apparent resistance with direct current and with alternating current of frequencies up to 80 per second (the usual correction for contact difference being found and applied).

Mr. W. Duddell suggested that the author should proceed with his experiments using very much higher frequencies.

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## SOCIETY OF CHEMICAL INDUSTRY.
### (London Section).

*Ordinary Meeting, December 3rd, 1906.*

Dr. J. Lewkowitsch in the Chair.

"*The Direct Estimation of Antimony*," by H. W. Rowell.

The sample of finely powdered ore or fine metallic sawings containing about 0·14 grm. of antimony is weighed into a 500 c.c. beaker, and dissolved in 25 c.c. of strong hydrochloric acid. Five c.c. of saturated solution of bromine in hydrochloric acid are run in, and any insoluble matter is fused in caustic soda and returned to the main bulk. Three grms. sodium sulphite are added, and the mixture boiled down to 10 c.c. to drive off sulphurous acid and arsenic. The solution is titrated at a boiling temperature, after the addition of 60 c.c. of hydrochloric acid (1 to 3), with N/20 potassium bromate until the colour of the methyl orange indicator is destroyed. The bromate is standardised with 0·082 grm. of arsenious oxide dissolved in hydrochloric acid, which is equivalent to 0·1 grm. of antimony. Copper raises the result slightly and iron very slightly, but precautions are given for obviating their effect.

The method may be applied to materials containing antimony, and examples are given illustrating the accuracy

of the method, the effect of copper and variations in samples of alloys.

"*The Standardisation of Disinfectants.*" By M. WYNTER BLYTH, B.A., B.Sc., F.I.C.

The present paper records the results of a number of tests made with disinfectants in the presence of organic matter which tend to prove that organic matter influences the efficience of disinfectants to an enormous extent. In the Rideal-Walker test the possible influence of organic matter was not considered. Fæces, urine, blood, and milk all influence the carbolic acid coefficients (*i.e.*, the dilution of a disinfectant which kills a given organism in a given time, divided by the dilution of carbolic acid which kills the same organism in the same time) of the majority of the disinfectants examined. There are, however, a few disinfectants, such as formalin and chinosol, which do not appear to be influenced by the presence of organic matter.

With emulsified tar oils the drop in coefficient on the addition of small quantities of certain organic matter is very great, but as more and more organic matter is added the drop becomes proportionately less until the coefficient is constant.

The particular types of organic matter which influence the coefficient to the greatest extent are fat and proteids; carbohydrates and bile soaps having little or any influence.

The coefficients in fæces lie between those obtained in separated milk and in whole milk. Fæces of any given composition may be imitated by taking milk of suitable richness in fat and proteids.

With oxidising disinfectants the drop in the coefficient obtained is proportional to the time during which the disinfectant and organic matter are allowed to remain in contact before adding the test organism. If, however, the organism is first added and then the disinfectant, the drop in coefficient is proportional to the oxidisable organic matter present, and may be represented by a straight line. It is pointed out that the organism used has a great influence on the coefficient obtained, a matter of importance when the coefficients are used for commercial purposes. As a general rule, it has been found that the higher the resistance of the organism is to carbolic acid the lower is the coefficient obtained for other coal-tar disinfectants.

Experiments are recorded on various strains of organisms of the coli group which show the importance of determining the cultural characteristics of any organism used, as different strains may give very different results. A modified thread method is suggested, and results are given which show that disinfectants containing soaps have considerably higher powers of penetration than is indicated by the ordinary thread method.

As a result of the author's investigations it is suggested that the efficiency of disinfectants can only be indicated by a series of figures obtained in water and in organic matter, and by both the drop and the thread methods. Even then the figures so obtained are only applicable to the particular organism used.

"*The Detannisation of Solutions in the Analysis of Tanning Materials.*" By Dr. J. GORDON PARKER and H. GARNER BENNETT, B.Sc.

The authors deal with the four chief methods used for the analysis of tanning materials and extracts, and compare the official method of the International Association of Leather Trades Chemists, which consists of detannisation by means of a column of prepared hide-powder in a specially made filter-bell, with the German method, with the method devised by Kopecky, and finally with the official American method.

The authors have carried out their experiments with materials of standard strength, using pure gallotannic acid, to which they have added various substances other than tannin, and show that such materials as glucose, dextrine, gallic acid, calcium acetate, and calcium lactate, ulphate of magnesia, salt, sodium bisulphite, and oxalic acid are all absorbed to a lesser or greater degree by hide-powder, and are returned by the official method of analysis as tannins. The authors give results of some four hundred analyses, using gallotannic acid admixed in various proportions with the above named materials. The result of the work is a vindication of the claims of the American method.

The authors confirm the work that has been done by Reed and other American chemists, and disprove the claims made by Paessler that a dry chromed hide-powder used in the filter-bell gives the most accurate results. The authors finally recommend that the International Association of Leather Trades Chemists should at once adopt the American method, either as it now officially stands or in a modified form.

## CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. cxliii., No. 22, November 26, 1906.

**Alcoholysis of Cocoa-butter.**—A. Haller and M. Yousoufian.—The fatty matter of cocoa has been the object of much research since the first investigation of it by Trommsdorf, published in 1815. Its importance as a food substance and the difficulty of freeing it from the butter and other natural fatty substances with which it occurs, add to the interest of the researches spent upon it. But in spite of the numerous analyses effected, the authors have not yet arrived at a unanimous statement of its constitution; *e.g.*, Ulzer doubts the presence of palmitine in this fatty substance, and Reyst finds in it neither palmitine nor stearine. Lewkowitsch, on the other hand, attributes to it the presence of both these glycerides together with those of caproic, caprylic, capric, lauric, myristic (the two latter in proportionately great quantity), and oleic acids. The authors of this article used for the alcoholysis the butter which is imported in considerably large quantities into Europe, and obtainable as such without transformation. The constants were determined and found to agree fairly well with most of the cocoa-butters described in chemical literature. The fatty substance was treated with absolute methyl and ethyl alcohols, according to the conditions mentioned in a previous note. In the final result the weight of ether salts obtained was equal to the weight of the fatty matter employed. Fractional distillation of the methyl-alcoholysis of the cocoa-butter yielded the caproate, caprylate, caprate, laurate, myristate, palmitate, stearate, and oleate of methyl. No butyric ether could be found in the mixture. In order to confirm the conclusion that cocoa-butters of different origin have the same composition as the commercial product analysed, experiments were made with other butters with the same result, and with no appearance of butyrine. To sum up, cocoa-butters contain the glycerides of the saturated fatty acids corresponding to $C_6$, $C_8$, $C_{10}$, $C_{12}$, $C_{14}$, $C_{16}$, $C_{18}$, and of oleic acid, among which laurine and myristine predominate.

**Improvement of the Eudiometer. Search for, and Estimation of, Carbon Monoxide.**—Nestor Gréhaut.—The author describes in detail the means by which he has perfected the mechanism of the eudiometer. He has put it to a new use in the investigation, as yet incomplete, of poisoning by carbon monoxide. Certain experimenters and hygienists affirm that this gas, even in infinitesimal quantities such as 1/100000, may cause serious results in man, and to test this opinion a series of comparative experiments were performed. Three rabbits as similar as possible were made to breathe definite mixtures of carbon monoxide and air equal to 1/5000 and 1/10000 for one hour, five hours, and nine hours respectively. Hæmoglobin is the best

absorbent of carbon monoxide; the gas was then extracted from the blood, to which tri-hydroxy-phosphoric acid was added, with the mercury pump, and the following results obtained. 100 c.c. of blood contain in c.c. of carbon monoxide:—

| | Mixture 1/5000. | Mixture 1/10000. |
|---|---|---|
| | C.c. | |
| At the end of 1 hour .. | 2·2 | 1·12 |
| " " 5 hours .. | 3·1 | 1·42 |
| " " 9 " .. | 3·1 | 1·43 |

These results are of the greatest importance; they prove that for small proportions of carbon monoxide the figures of the gas absorbed by the blood at the end of five hours and at the end of nine hours are identical; there is therefore in the curve of the results obtained a horizontal resembling that which the author has discovered in his researches upon alcohol poisoning.

**A Method of Preparing Hydrated Hypovanadic Acid.**—Gustave Gain.—The author has succeeded in preparing on a large scale this body, which hitherto has been obtained with difficulty. The starting-point is the metavanadate of ammonia, which on heating in a crucible is transformed into a deep blue powder, a mixture of $V_2O_3$ and $V_2O_4$. This, after heating for several days with a saturated solution of sulphurous anhydride, became a beautiful azure-blue colour, part of the dark blue powder being transformed into a light blue body consisting of fine needles, a sulphite of $V_2O_4$, which on analysis pointed to the formula $2V_2O_4,3SO_2.10H_2O$. A certain quantity of the azure-blue liquid was then gently heated, causing, first, evolution of $SO_2$, and, finally, deposition of a fine crystalline powder. This deposition increased with slow prolonged cooling. Analysis of the crystals gave the formula $V_2O_4,2H_2O$. From this hydrate a certain number of salts of hypovanadic acid were also obtained.

**Research upon the Elements producing Phosphorescence in Minerals. The case of Chlorophane, a Variety of Fluorite.**—G. Urbain.—The author has previously described most of the phosphorescences observable on submitting to the action of the cathode rays, mixtures of pure chalk with the pure oxides of the different rare earths. By this method traces of bodies are detected which would by any other method escape unnoticed. The same method is now applied to certain phosphorescent minerals, in particular to some fluorites, which manifest this property in high degree. The chemical causes of the phosphorescence of fluorites had not yet been experimentally investigated. Chlorophane, the most remarkable of the varieties of fluorite, emits on heating a beautiful greenish-white light (whose spectrum H. Becquerel has described). The bands, easily observable in the cathode region, appeared to indicate that the phosphorescence of chlorophane was due to rare earths, and this the author has proved to be the case, both by analysis and synthesis. By the method of analysis the fluoride was transformed into oxide. After comparisons of various spectra, traces of the following elements were detected in chlorophane:—samarium, terbium, dysprosium, and gadolinium. A partial synthesis of the phosphorescent fluorites was necessary for the further definition of the phosphorescent element of chlorophane. The fused amorphous precipitated fluorides were used. By this means, the different bands of phosphorescence of chlorophane were properly ascribed to the corresponding rare earths, already indicated by spectrum analysis.

**Transformation of Cinnamic Alcohol into Phenyl Propylene and Phenyl Propylic Alcohol by the Ammonium Metals.** — E. Chablay.—Previous experimenters have, by the action of nascent hydrogen upon cinnamic alcohol, converted it into phenyl propylene and phenyl propylic alcohol. The author gets the same result by the action of sodammonium upon cinnamic alcohol. A clear, yellow solid substance results, which is decomposed by water, dissolved in anhydrous ether, and submitted to fractional distillation. A phenylpropylene was isolated, of the formula $C_9H_{10}Br_2$, between 165° and 170°. Phenylpropylic alcohol was obtained from rectification of the fractions distilling at 235° to 250°, it being a liquid distilling at a constant temperature at 236—237°. Analysis gave it the formula $C_9H_{12}O$. Oxidation with chromic acid in acetic acid solution transformed it into phenylpropionic acid, $C_6H_5—CH_2—CH_2—COOH$, fuzing at 47·5°. The alcohol is a thick, colourless liquid, with an agreeable flowery odour. The experiment proves that the metallic ammoniums reduce cinnamic acid, just as they reduce the non-saturated alcohols of the fatty series to give the corresponding carbide, and with similar working. But the reduction is the minor part of the reaction, the principal result being the formation of phenylpropylic alcohol.

**Preparation of the Oxynitriles $ROCH_2CN$.**—D. Gauthier.—The author starts with the monochlor ether oxides, $R—O—CH_2Cl$. In these compounds, treated with mercuric cyanide, or preferably with cupric cyanide, the group CN easily replaces Cl, and furnishes a new series of compounds, $R—O—CH_2—CN$. Of this, only one term was already known, viz., the oxynitrile, $C_2H_5—O—CH_2—CN$, being prepared by dehydrating the coresponding amide by means of phosphoric anhydride, but the author's method yields also methyl, propyl, isobutyl, and amyl glycolic nitriles (after fractional distillation), corresponding to the chlor-ether used. These compounds, $R—O—CH_2—CN$, were also transformed into their more immediate derivatives, *e.g.*, $R—O—CH_2—CONH_2$ (ether-oxides of glycolamide), $R—O—CH_2—COOH$ (etheroxides of glycolic acid), $R—O—CH_2—COOR'$ (ether-salts of the preceding acids). By this method of formation 80 per cent of the theoretical yield was obtained.

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*Berichte der Deutschen Chemischen Gesellschaft.*
Vol. xxxix., No. 14, 1906.

**Carbohydrates of Cocoa.**—A. D. Maurenbrecher and B. Tollens.—The authors have investigated the individual carbohydrates occurring in cocoa-beans. They first removed the husk and extracted the fat from the beans, and then found in the fat-free powder 5·51 per cent of pentosan. When the powdered beans were extracted with ether and subjected to hydrolysis with sulphuric acid, they found in the products *l*-arabinose, *d*-galactose, *d*-glucose, and probably xylose is also present. The same products are found in the husk. From the fat of the beans, cocoa-butter, the authors succeeded in isolating phytosterin.

**Addition Reactions of Dicyandiamide with Inorganic Salts.**—Hermann Grossmann and Bernhard Schück.—When aqueous solutions of dicyandiamide and copper sulphate are warmed together on a water-bath, a light blue crystalline precipitate is obtained, while from the light blue filtrate green basic compounds of inconstant composition can be isolated. The formula of the precipitate is $CuSO_4.2C_2H_4N_4.4H_2O$. The corresponding cadmium compound, $CdSO_4.2C_2H_4N_4.2H_2O$, crystallises in short colourless prisms. It is much more soluble in water than the copper compound, and is therefore obtained only from concentrated solutions. Pointed glittering needles of $HgCl_2.C_2H_4N_4$ crystallise from a solution of one molecule of mercuric chloride with two molecules of dicyandiamide.

**Atomic Weight of Potassium.**—Theodore W. Richards and Arthur Stähler.—For the preparation of the material, pure commercial potassium nitrate was dissolved in a little water, filtered from solid substances, and re-crystallised. The salt was freed from mother-liquor in a porcelain centrifuge, the re-crystallisation repeated in platinum vessels, and the material was then divided into two parts. One was dried *in vacuo*, and the other was re-crystallised six times in platinum vessels. The nitrate was then dissolved in cold water and saturated with pure hydrochloric acid, the platinum vessel in which the operation was performed being surrounded with ice. The potassium chloride

thus obtained was then freed from traces of potassium platinochloride centrifugally. To determine the ratio KCl : AgCl the method described by Richards and Wells for the determination of the atomic weight of sodium was adopted. The potassium chloride was weighed in platinum vessels closed with platinum stoppers, all weighings being performed by the substitution method. The silver nitrate used was carefully purified by re-crystallisation, and the precipitation was effected in an Erlenmeyer flask of Jena glass. The potassium chloride solution was introduced into the flask, and small quantities of silver nitrate added in a dark room lighted with a red light only. The filtration was effected in a Neubauer crucible (made by the firm of Heraeus). Special care was taken in correcting for the solubility of silver chloride. To determine the ratio KCl : Ag, silver was precipitated from re-crystallised silver nitrate by means of ammonium formate, and the metal thus obtained was fused, first in a current of electrolytic hydrogen, and then in a vacuum of 0·1 m.m. in a Heraeus furnace. The fusion took place in a boat of pure calcium oxide. The numbers obtained from the ratio of KCl to AgCl agreed perfectly with those obtained from the ratio of KCl : Ag. In both cases if Cl = 35·473 and Ag = 107·93, potassium = 39·114.

**Analysis of Hydrofluosilicic Acid.**—L. Schucht and W. Möller.—With both methyl-orange and phenolphthalein as indicator the titration of hydrofluosilicic acid with alkali, according to the equation $H_2SiF_6 + 2KOH = K_2SiF_6 + 2H_2O$, gives slightly inaccurate results, owing to the disturbing effect of the water formed. If, however, excess of neutral calcium chloride solution is added to the hydrofluosilicic acid solution it can be titrated easily in the cold, with methyl-orange as indicator. The equation is :—

$$H_2SiF_6 + 3CaCl_2 + 6NaOH = 3CaF_2 + 6NaCl + H_4SiO_4 + 2H_2O.$$

**Volumetric Determination of Mercury.**—E. Rupp.—One to 2 grms. of potassium iodide are added to a solution of a mercuric salt (about 0·2 grm. in 25 to 50 c.c.), the solution is then made alkaline with caustic potash or caustic soda, and a mixture of 2 to 3 c.c. of pure 40 per cent formaldehyde solution and 10 c.c. or water is added, the whole being well shaken. After one-half to one minute acetic acid is added till the mixture smells distinctly of it, and then excess of N/10 iodine (25 c.c.). The finely divided mercury disappears quickly if the solution is shaken thoroughly. When all traces of the metal have disappeared, the excess of iodine is determined with N/10 thiosulphate solution, with or without starch as an indicator. To determine mercurous compounds they must first be converted into the mercuric compound. In the case of the halogen salts this may be effected by means of bromine. For mercurous nitrate and sulphate it is best to acidify with the corresponding acid and add permanganate solution till the red coloration does not disappear. To determine mercury in mercuric cyanide solution, after proceeding as above some sulphuric acid must be added before titrating with thiosulphate.

## MEETINGS FOR THE WEEK.

MONDAY, 17th.—Society of Arts, 8. (Cantor Lectures). "Artificial Fertilisers—their Nature and Functions," by A. D. Hall.

TUESDAY, 18th.—Society of Arts, 8. "Basket Making," by T. Okey.

WEDNESDAY, 19th.—Society of Arts, 8. "Modern Developments of Flour Milling," by A. E. Humphries.

— Microscopical, 8. Exhibition of Slides from the Collection presented to the Society by Mr. Jas. Hilton.

THURSDAY, 20th.—Chemical, 8 30. "New Laboratory Method for the Preparation of Hydrogen Sulphide," by F. R. I. Wilson "Reaction of Acids with Methyl-orange," by V. H Veley. "Contributions to the Study of the Calcium phosphates—(1) The Hydrates of the Calcium-hydrogen Orthophosphates; (2) Action of Ammonia Gas on the Calcium-hydrogen Orthophosphates," by H. Bassett, jun.


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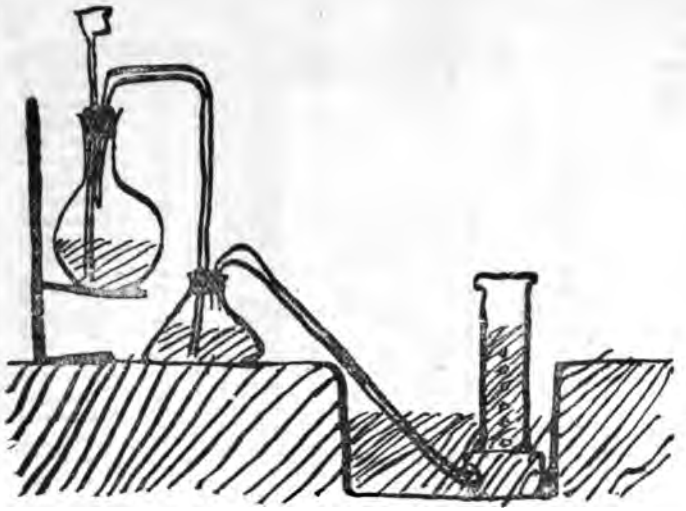

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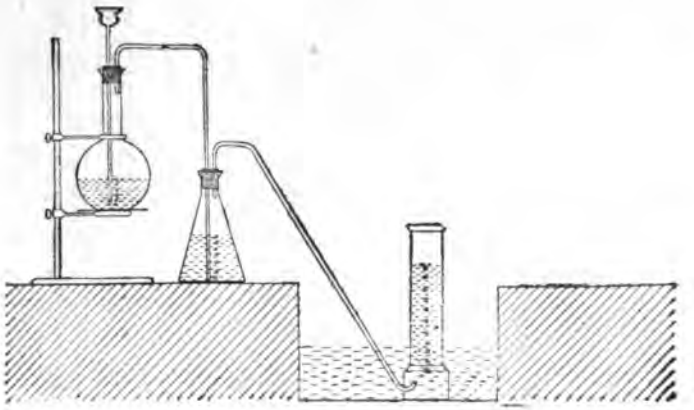

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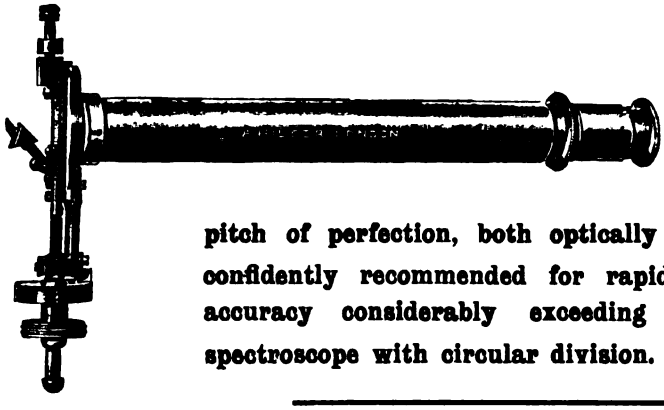

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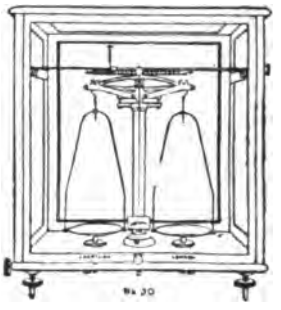

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THE CHEMICAL NEWS.

VOL. XCIV., No. 2456.

## NOTE ON FLUORESCENCE, LUMINESCENCE, AND CHEMICAL CONSTITUTION.

By C. S. STANFORD WEBSTER, F.I.C.

IN a recent research of L. Francesconi and G. Bargellini (*Journ. Chem. Soc.*, 1906, ii., 714) by adopting a very delicate method of detecting fluorescence, it has been established that the groups $NH_2$, OH, and COOH when attached to the benzene ring increase fluorescence and that $NO_2$, Cl, Br, &c., and the substituents acetyl and benzoyl diminish it. It is noteworthy that this increase of fluorescence of a substance in solution when sunlight is the exciting agent runs parallel with the luminescence when the latter is exposed to the rays emitted by a salt of radium; and those groups or substituents which diminish the fluorescence in the first also diminish the luminescence in the second case.

A considerable amount of work on the luminescence peculiar to aromatic compounds has been published by H. Kauffmann (*Journ. Chem. Soc.*, 1906, i., 283), and H. Kauffmann and A. Grombach (*Journ. Chem. Soc.*, 1905, i., 280). Results of a precisely similar character have been obtained by the author in studying the luminescence of aromatic compounds, as, for instance, salicylic acid and derivatives. When these results are tabulated, *i.e.*, in the order of luminescence, it is seen that the order is a certain criterion of constitution.

It is clear therefore that comparative observations of a new compound by means of the luminiscope (*Journ. Soc. Chem. Ind.*, Dec. 31, 1904, p. 1185) affords a means of verifying constitution, and the method is especially useful in cases where a compound is isolated in too minute a quantity for analysis.

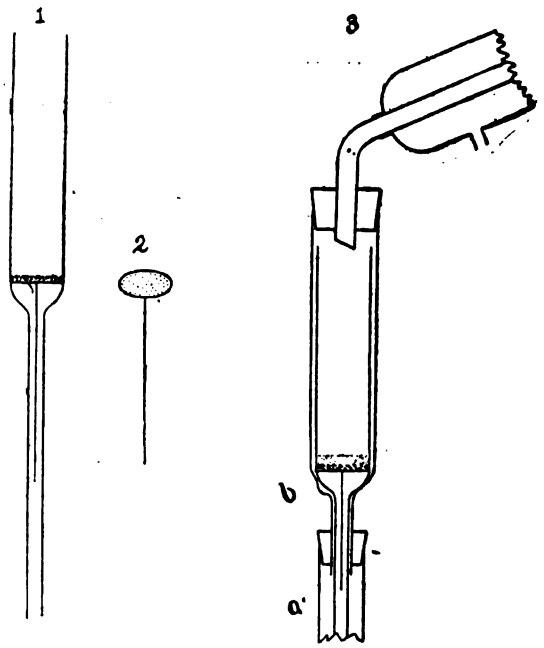
## FILTER-TUBES FOR COLLECTION OF PRECIPITATES ON ASBESTOS.

By S. L. PENFIELD and W. M. BRADLEY.

THE tubes described in this article may be employed to advantage in a variety of analytical operations, and as an inexpensive substitute for a Gooch crucible, where a high temperature is not required.

The tubes (Fig. 1) may readily be drawn out from combustion tubing, or made from soft glass if high temperatures are not used. Different lengths and sizes will find a variety of uses, and diameters from 17 to 20 m.m. may be recommended for general use. The most satisfactory support for asbestos is a perforated platinum disc 0·2 m.m. in thickness, to the centre of which a platinum-wire three inches long is soldered (Fig. 2). Where conditions or expense prohibit the use of platinum, a filter-bed of quartz may be substituted with excellent results. A large fragment is used to close the throat of the filter-tube, and on this is placed a layer of powdered quartz about six or eight times as coarse as sea-sand, from which fine material has been carefully removed by screening and washing. In order to deposit a uniform layer of asbestos on the quartz, it is recommended to observe the following precautions:—The bottom of the filter-tube is closed with the finger, and the tube is half filled with water; asbestos suspended in water is then added, when upon removing the finger, it will settle in a smooth layer upon the quartz, and may be firmly fixed by use of a filter-pump. The asbestos and precipitate collected on it dry slowly in the tubes in an ordinary drying oven, but removal of water may be quickly accomplished by drawing a slow current of air through the tubes, the latter being heated in an air-bath, which may be improvised from a baking-powder can. Such filters may be found useful for collecting many precipitates which need not be subjected to strong ignition, silver chloride, for example, and they are especially recommended for precipitates which are subsequently to be ignited in gases, as will be illustrated by numerous examples. They are admirably adapted for use with an extractor, where either a precipitate collected on the asbestos, or a powder, is to be treated with some solvent, such as either carbon bisulphide or alcohol. The arrangement of a filter-tube in an extractor is suggested by Fig. 3, where *a* is the neck of a flask containing some solvent, the vapours of which pass up between the filter-tube and the outer jacket, and after condensation drop down upon the material collected on the asbestos. At *b* there should be some swelling of the tube to allow a free upward passage of vapours.

In case of a small amount of organic material being present, it could undoubtedly be burned in the tube in oxygen gas and the resulting carbon dioxide and water collected and weighed.




Precipitates collected on the asbestos can be ignited by applying a gentle heat to the tubes while supported in an inclined position, or the following arrangement may be found very serviceable:—A small hole is pierced in the bottom of a porcelain crucible and enlarged by chipping until a hole of the desired diameter is obtained, through which is passed the smaller part of the filter-tube. The crucible not only serves as a support for the tube, but also protects the glass and precipitate from too strong ignition. A ring burner is placed beneath the crucible, and so adjusted that the lower part of the filter-tube passes through the centre of the burner, and may by its lower end be connected to a gas generator. If it is desired to increase the temperature of the upper part of the tube, this may be accomplished by using wire-gauze, so placed as to deflect the heat to that portion.

In order to test the apparatus just described with precipitates requiring ignition in gases, a number of experiments have been carried out with the following results:—

Calcium ignited in $CO_2$ and weighed as $CaCO_3$.

| | Precipitated as $CaCO_3$. | Precipitated as $CaC_2O_4$. |
|---|---|---|
| Calcite taken .. .. | 0·7445 | 0·7191 |
| $CaCO_3$ weighed .. | 0·7450 | 0·7195 |
| Error.. .. .. .. | +0·0005 | +0·0004 |
| Error as CaO .. .. | 0·0003 | 0·0002 |

The collection of a considerable portion of calcium oxalate on an asbestos-filter can scarcely be recommended, because the exceedingly fine precipitate clogs the asbestos and makes the filtration tedious.

Copper in re-crystallised copper sulphate was precipitated by means of hydrogen sulphide and ignited in $CO_2$.

$CuSO_4.5H_2O$ taken = 0·1936.

| | |
|---|---|
| $Cu_2S$ calculated .. .. .. | 0·0617 |
| $Cu_2S$ weighed.. .. .. .. | 0·0618 |
| Error .. .. .. .. .. .. | +0·0001 |

Zinc in re-crystallised potassium double sulphate $K_2SO_4.ZnSO_4.6H_2O$ was precipitated by hydrogen sulphide in formic acid solution, ignited in $CO_2$, and weighed as ZnS.

$K_2SO_4.ZnSO_4.6H_2O$ taken 0·5265.

| | |
|---|---|
| ZnO calculated .. .. .. | 0·0965 |
| ZnO determined .. .. .. | 0·0960 |
| Error .. .. .. .. .. .. | −0·0005 |

Lead in pure galena was precipitated by hydrogen sulphide in acetic acid solution, after decomposing the mineral with nitric acid, and dissolving lead sulphate with ammonium acetate. Lead sulphide was ignited in hydrogen sulphide and weighed.

| | |
|---|---|
| Galena taken .. .. .. .. | 0·2494 |
| PbS weighed .. .. .. .. | 0·2494 |
| Error .. .. .. .. .. .. | 0·0000 |

Arsenic in sublimed arsenious oxide was precipitated by hydrogen sulphide after dissolving in pure sodium carbonate, and acidifying with hydrochloric acid.

The arsenious sulphide was subjected to the action of carbon bisulphide for the removal of sulphur, using the extractor illustrated by Fig. 3.

$As_2O_3$ taken 0·1890.

| | |
|---|---|
| $As_2S_3$ calculated .. .. .. | 0·2350 |
| $As_2S_3$ weighed .. .. .. | 0·2357 |
| Error .. .. .. .. .. .. | +0·0007 |

Antimony in Japanese stibnite was precipitated by hydrogen sulphide after dissolving the mineral in hydrochloric acid. The $Sb_2S_3$ was ignited in $CO_2$ gas.

| | |
|---|---|
| Stibnite taken.. .. .. .. | 0·1385 |
| $Sb_2S_3$ weighed .. .. .. | 0·1384 |
| Error .. .. .. .. .. .. | −0·0001 |

Bismuth in pure $Bi_2O_3$ was precipitated by hydrogen sulphide after dissolving the oxide in the least possible amount of dilute nitric acid, and diluting largely before precipitation.

$Bi_2S_2$ was ignited in $CO_2$ and weighed.

| | |
|---|---|
| $Bi_2O_3$ taken .. .. .. .. | 0·3047 |
| $Bi_2O_3$ determined .. .. .. | 0·3046 |
| Error .. .. .. .. .. .. | −0·0001 |

Thanks are here expressed to Dr. W. E. Ford, who kindly furnished the results of the last two determinations.

Filter-tubes such as here described have been in use for many years in our laboratory, and have frequently been employed in the estimation of potassium as platinic chloride; on subsequent ignition in hydrogen gas the salt may be decomposed, the alkali chloride extracted with water, and tested spectroscopically for cæsium and rubidium.—*American Journal of Science*, [4], xxi., No. 126.

## THE USE OF THE ROTATING CATHODE FOR THE ESTIMATION OF CADMIUM TAKEN AS THE CHLORIDE.

By CHARLES P. FLORA.

In a previous paper the author has described the use of the rotating cathode for the estimation of cadmium taken as the sulphate (*Am. Journ. Sci.*, 1905, xx., 268; Chemical News, xciv., pp. 274, 283). In the present paper a similar study has been made of the behaviour of cadmium when taken in the form of the chloride. Some differences are to be expected, since it has been established with some certainty that cadmium chloride, when subjected to electrolysis, forms not only positive cadmium ions and negative chlorine ions, but also complex cadmium-chlorine negative ions; and, in addition, the chlorine, when set free, does not re-combine with the water, to set free oxygen, but exists in the solution in its free state. That there are some very important differences a few qualitative experiments showed, so that the study of the estimation of cadmium when taken in the form of this salt was now undertaken.

A solution was made up to a convenient strength, and the standard determined by the mean of several closely agreeing determinations by the carbonate method, which the author had carefully tested and found to be perfectly reliable. This showed 0·1589 grm. of cadmium in 30 c.c. of the solution, or 0·0052966 grm. per c.c.

### I. *In Solutions containing Sulphuric Acid.*

The procedure with cadmium chloride was the same as with the cadmium sulphate, and the results were very satisfactory. But emphasis is to be laid upon the dilution in this case especially, for it was found that from the more dilute solution it is almost impossible to drive the last traces of cadmium. A dilution of 45 c.c. was found to give the most satisfactory results. To this solution ten drops of sulphuric acid of 1 : 4 dilution were added before electrolysis. The results obtained under these conditions are given in Table I.

### II. *In Solutions containing Acetates.*

The acetate method has proved one of the most satisfactory for the estimation of cadmium sulphate, but strangely enough, it was found to be absolutely unfitted for the estimation of cadmium when taken as the chloride. The deposited metal was always spongy, often non-adherent and unfitted for quantitative work. The sponginess was less marked when no potassium sulphate was present, but the metal was still poorly adherent and unweighable. The modifications tried are given for the sake of comparison in Table II. The current potentia throughout was 7·8 volts, while the dilution, excepting in experiment No. 4, was 45 c.c. In No. 4 a dilution of 65 c.c. was tried, but it offered no apparent advantage.

### III. *In Solutions containing Cyanides.*

The use of a cyanide solution gave results with the chloride of cadmium as satisfactory as were given when the sulphate of cadmium was taken. As in that case, care must be taken to avoid foaming of the solution. The best dilution seemed to be 65 c.c. The time required is a trifle longer than in the estimation of cadmium sulphate by this method. The results obtained are given in Table III.

In experiment No. 2 there was much foaming, and a trace of cadmium remained in solution, the deposition being much retarded.

### IV. *In Solutions containing Pyrophosphates.*

The different modifications of the pyrophosphate method gave results which were quite satisfactory, and in every respect comparable with the results obtained with this electrolyte in the estimation of cadmium sulphate. As was the case with that salt, the use of ammonium hydroxide to

TABLE I.

| No. | Cd. Grm. | Current = Ampères. | N.D.$_{100}$. Ampères. | E.M.F. Volts. | Time. Minutes. | Cd found. Grm. | Error. Grm. |
|---|---|---|---|---|---|---|---|
| 1. | 0·1059 | 1·0—1·5 | 3·0—4·5 | 6·5—7·8 | 25 | 0·1054 | − 0·0005 |
| 2. | 0·1059 | 2·0—3·0 | 6·0—9·0 | 7·8 | 15 | 0·1058 | − 0·0001 |

TABLE II.

| No | Cd. Grm. | $NaOC_2H_3O$. Grm. | $K_2SO_4$. Grm. | Current = Ampères. | N.D.$_{100}$. Ampères. | Time. Minutes. | Notes. |
|---|---|---|---|---|---|---|---|
| 1. | 0·1324 | 1·5 | 0·5 | 1·5 | 4·5 | 13 | Very spongy. |
| 2. | 0·1324 | 1·5 | None | 1·0 | 3·0 | 8 | 0·1314 grm. found. |
| 3. | 0·1059 | 1·0 | None | 0·75 | 2·25 | 20 | Non-adherent. |
| 4. | 0·1059 | 1·5 | 0·5 | 1·5 | 4·5 | — | Spongy, non-adherent. |
| 5. | 0·1059 | 1·5 | None | 1·0 | 3·0 | — | 2 c.c. formalin added; spongy. |
| 6. | 0·1059 | 1·5 | None | 0·75 | 2·25 | — | Non-adherent, crystalline. |
| 7. | 0·1059 | 0·5 | 0·5 | 1·0 | 3·0 | — | " " |

TABLE III.

| No: | Cd. Grm. | KCN. Grms. | NaOH. Grm. | Current = Ampères. | N.D.$_{100}$. Ampères. | E.M.F. Volts. | Time. Minutes. | Cd found. Grm. | Error. Grm. |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 0·1324 | 1·5 | 1·0 | 4 | 12 | 7·8 | 35 | 0·1322 | − 0·0002 |
| 2. | 0·1324 | 1·5 | 1·0 | 4 | 12 | 7·8 | 40 | 0·1317 | − 0·0007 |

TABLE IV.

| No. | Cd. Grm. | Solvent. | Current = Ampères. | N.D.$_{100}$. Ampères. | Time. Minutes. | Cd found. Grm. | Error. Grm. |
|---|---|---|---|---|---|---|---|
| 1. | 0·1324 | 1 c.c. concentrated $NH_4OH$ | 0·5 | 1·5 | 15 | 0·1327 | + 0·0003 |
| 2. | 0·1324 | 12 drops $H_2SO_4$ (1·4) | 0·75 | 2·25 | 35 | 0·1328 | + 0·0004 |
| 3. | 0·1324 | 15 drops $H_3PO_4$ (sp. gr. 1·7) | 0·75—1·0 | 2·25—3·0 | 30 | 0·1331 | + 0·0007 |
| 4. | 0·1324 | 15 drops HCl (1 : 4) | 0·7—0·5 | 2·1—1·5 | 45 | 0·1319 | − 0·0005 |

TABLE V.

| No. | Cd. Grm. | $HNa_2PO_4$. Grm. | $H_3PO_4$ (sp. gr. 1·7). | Current = Ampères. | N.D.$_{100}$. Ampères. | E.M.F. Volts. | Time. Minutes. | Cd found. Grm. | Error. Grm. |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 0·1059 | 0·25 | 5 c.c. | 2·0—3·0 | 6·0—9·0 | 7·8 | 15 | 0·1082 | + 0·0023 |
| 2. | 0·1324 | 0·25 | 2·5 c.c. | 2·0—3·0 | 6·0—9·0 | 7·8 | 13 | 0·1344 | + 0·0020 |
| 3. | 0·1324 | 0·20 | 10 drops | 1·0 | 3·0 | 7·8 | 15 | 0·1330 | + 0·0006 |
| 4. | 0·1324 | 0·20 | 6 drops | 0·25 | 0·75 | 7·8 | 35 | 0·1310 | − 0·0014 |

TABLE VI.

| No. | Cd. Grm. | Urea. Grm. | Current = Ampères. | N.D.$_{100}$. Ampères. | E.M.F. Volts. | Time. Minutes. | Total vol. C.c. | Cd found. Grm. | Error. Grm. | Notes. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | *Series* A.—Urea. | | | | | | |
| 1. | 0·1324 | 3 | 1·0 | 3·0 | 12 | 20 | 60 | 0·1312 | − 0·0012 | Spongy; not all out. |
| 2. | 0·1324 | 2 | 1·0 | 3·0 | 12 | 30 | 60 | 0·1336 | + 0·0012 | " " |
| 3. | 0·1324 | 3 | 1·0 | 3·0 | 7·8 | 15 | 55 | 0·1342 | + 0·0018 | Very spongy; all out. |
| 4. | 0·1324 | 2 | 0·25 | 0·75 | 7·8 | 25 | 60 | 0·1324 | 0·0000 | All out. |
| 5. | 0·1324 | 2 | 0·5 | 1·5 | 12 | 20 | 60 | 0·1333 | + 0·0009 | Slightly spongy; all out. |
| 6. | 0·1324 | 1 | 1·0 | 3·0 | 12 | 20 | 60 | 0·1370 | + 0·0046 | Very spongy. |
| 7. | 0·1324 | 1·5 | 0·25—0·5 | 0·75—1·5 | 7·8 | 30 | 60 | 0·1328 | + 0·0004 | Good. |
| 8. | 0·1324 | 1·5 | 0·25—0·5 | 0·75—1·5 | 7·8 | 30 | 60 | 0·1329 | + 0·0005 | Fair. |
| | | | | *Series* B.—Formaldehyde (Formalin). | | | | | | |
| | | Formaldehyde. | | | | | | | | |
| 1. | 0·1324 | 3·0 c.c. | 0·25—1·5 | 0·75—4·5 | 7·8 | 20 | 45 | 0·1333 | + 0·0009 | Fair. |
| 2. | 0·1324 | 2·0 " | 0·50—2·0 | 1·50—6·0 | 11·8 | 15 | 45 | 0·1330 | + 0·0006 | Slightly spongy. |
| 3. | 0·1324 | 1·5 " | 0·75 | 2·25 | 7·8 | 30 | 60 | 0·1324 | 0·0000 | Compact. |
| 4. | 0·1324 | 1·5 " | 1·0 | 3·0 | 7·8 | 35 | 60 | 0·1325 | + 0·0001 | Compact. |
| | | | | *Series* C.—Acetaldehyde (95 per cent). | | | | | | |
| | | Aldehyde (95 %). | | | | | | | | |
| 1. | 0·1324 | 2·0 c.c. | 0·2—0·7 | 0·6—2·1 | 7·8 | 30 | 60 | 0·1311 | − 0·0013 | Not all out; slightly spongy. |
| 2. | 0·1324 | 1·5 " | 0·5—0·75 | 0·6—2·25 | 7·8 | 30 | 60 | 0·1346 | + 0·0022 | Spongy. |
| 3. | 0·1324 | 0·5 " | 0·2—1·0 | 0·6—3·0 | 7·8 | 65 | 60 | 0·1307 | − 0·0017 | Spongy; not all out. |
| 4. | 0·1324 | 1·0 " | 0·1—0·75 | 0·3—2·25 | 8·0 | 35 | 60 | 0·1328 | + 0·0004 | Fair. |

dissolve the precipitate gave the most satisfactory results; while after that, sulphuric acid seemed to be the most suitable solvent. The deposits obtained from solutions to which were added free phosphoric acid showed a slight tendency toward sponginess. When hydrochloric acid was added, the deposits were good but deposition was slow. The total volume in each case was 45 c.c.; the amount of sodium pyrophosphate used was 9·5 grms.; while the current potential was 7·8 volts. The results obtained are given in Table IV.

V. *In Solutions containing Phosphates.*

With cadmium chloride, hydrogen disodic phosphate must be used with even more care than with cadmium sulphate, if deposits which are even slightly satisfactory are to be obtained; and even when used with caution, the tendency to form spongy deposits is so persistent that this method is not to be recommended where other methods are available. Table V. gives the solutions tried, the concentration being 45 c.c. throughout.

Nos. 1 and 2 gave spongy deposits; No. 4 showed no colour upon testing the solution at the end of the operation with hydrogen sulphide, but this test does not seem to be very sensitive in this solution. No. 3 seems to represent the best conditions.

VI. *In Solutions containing Oxalates.*

Several qualitative tests, using conditions identical with those giving the least unsatisfactory deposits with cadmium sulphate, were tried upon the cadmium chloride, with like unsatisfactory results, so that the work upon the oxalate method was not pursued further.

VII. *In Solutions containing Urea, &c.*

A few qualitative tests seemed to indicate that solutions containing urea, formaldehyde, or acetaldehyde would furnish very satisfactory media for the estimation of cadmium, taken in the form of the chloride, but further experimentation proved these appearances to be deceptive. Under these conditions, the cadmium is deposited much more quickly from a solution of its chloride than of the sulphate, and the deposit in the earlier part of the precipitation appears to be very satisfactory. But the chlorine set free apparently has some action upon the organic compound present to produce substances deterimental to the process. With care, however, satisfactory results may be obtained, as may be seen from a study of Table VI.

The amount of urea present, therefore, should be between 1·5 grm. and 2 grms., and the current potential should not exceed 8 volts, instead of the 12 volts permissible when cadmium sulphate was used. The test with hydrogen sulphide does not seem to be very delicate in this solution, so that at least thirty minutes should be allowed for each determination. Some writers recommend the testing of the end-point in similar cases by raising the level of the liquid upon the cathode, but this was not proved of much value in this work, as the amount of metal deposited upon the fresh cathode surface from the solutions near the end of the process is imperceptible.

A solution to which formaldehyde was added gave the results stated in Series B.

It will be seen from these results that it is better to use a somewhat smaller quantity of formaldehyde than was used with the cadmium sulphate; the current potential should not exceed 8 volts, while the solution should be rather dilute (60 c.c.).

These cautions are of even greater importance when acetaldehyde is used, if satisfactory results are to be obtained, as shown in Series C.

VIII. *In Solutions containing Formates and Tartrates.*

Like cadmium sulphate, so also cadmium chloride gave negative results when solutions containing in addition potassium formate in the presence of formic acid were subjected to electrolysis. Moreover, when no formate was added, but formic acid alone, the results were still unsatisfactory. To solutions containing 0·1324 grm. of cadmium in the form of the chloride was added 1·5 c.c. of formic acid, the whole diluted to 50 c.c., and electrolysis conducted under potentials of 7·5 and 11·8 volts. In each case the precipitate was spongy and non-adherent, while the solution persistently held traces of cadmium, even after subjecting to the current nearly two hours.

Solutions containing tartaric acid behaved in a similar manner. In the presence of 3 grms. of tartaric acid, under current tensions of 8 and 12 volts, the precipitated metal peeled from the cathode during revolution, the deposit was spongy, and deposition seemed to be complete at no point of the operation.—*American Journal of Science*, xx., p. 392.

## ADDITIONAL NOTES UPON THE ESTIMATION OF CADMIUM BY MEANS OF THE ROTATING CATHODE, AND SUMMARY.

By CHARLES P. FLORA.

I. *The Behaviour of Cadmium Nitrate.*

SINCE cadmium is not readily precipitated by the electric current from solutions containing even small amounts of free nitric acid, it was to be expected that cadmium nitrate would prove to be little fitted for estimation by electrolysis, since the action of the current would produce nitric acid. This, in general, was the result of my experiments upon the estimation of cadmium in the form of the nitrate upon the rotating cathode. The deposits obtained from solutions containing sulphuric acid, the phosphates, pyrophosphates, urea, or formaldehyde, were satisfactory, but the time necessary for complete deposition is so prolonged that these solutions are comparatively valueless for the estimation of cadmium taken as the nitrate, since it would be easier and more trustworthy to transform the salt to the sulphate by evaporation with sulphuric acid before electrolysing. With solutions containing acetic acid the metal was not precipitated except in a narrow ring at the surface of the liquid. The behaviour of solutions containing formic acid, tartaric acid, acetaldehyde, and formaldehyde was similar, but less pronounced. The only solution from which I was able to obtain satisfactory results in the estimation of cadmium nitrate was a solution containing potassium cyanide. This solution was prepared by adding to the solution of cadmium nitrate, which had been standardised by the precipitation and ignition of the carbonate, the desired amount of sodium hydroxide, and then re-dissolving the precipitated hydroxide in an excess of potassium cyanide. The time needed for complete deposition is somewhat longer than that required where the chloride and sulphate of cadmium were taken, but the deposit was bright and very satisfactory. Care must be used to avoid the use of too large an amount of potassium cyanide. The following table shows the results obtained:—

| | 1. | 2. | 3. |
|---|---|---|---|
| Cadmium taken (grm.) .. | 0·0920 | 0·0920 | 0·1073 |
| Cadmium found (grm.) .. | 0·0933 | 0·0924 | 0·1072 |
| Error (grm.) .. .. .. | +0·0013 | +0·0004 | −0·0001 |
| KCN (grm.) .. .. .. | 1·5 | 1·0 | 0·7 |
| NaOH (grm.) .. .. .. | 0·5 | 0·5 | 0·5 |
| Current (ampère) .. .. | 4·0 | 3·0 | 2·5 |
| $N.D._{100}$ (ampère) .. .. | 12·0 | 9·0 | 7·5 |
| E.M.F. (volts).. .. .. | 7·8 | 7·6 | 7·7 |
| Time (minutes) .. .. | 45 | 35 | 50 |
| Total volume (c.c.).. .. | 60 | 60 | 60 |

II. *Behaviour of Solutions containing Free Nitric Acid.*

If free nitric acid be added to a solution containing a salt of cadmium, the precipitation of the cadmium by the electric current will be retarded, and even prevented altogether if the nitric acid be present in sufficient amount. Upon this behaviour have been based methods for the

separation of copper, bismuth, and mercury from cadmium (Edgar F. Smith, *Am. Chem. Journ.*, 1880, ii., 42; Smith and Mayer, *Journ. Chem. Soc.*, 1893, lxiv., [ii.], 496); Kammerer, *Journ. Am. Chem. Soc.*, 1903, xxv., 94; Rüdorff, *Zeit. Angew. Chem.*, 1894, 388). Tests were made by me to determine the amount of free nitric acid necessary to prevent deposition of the cadmium, and it was found that 2 c.c. of nitric acid of 1 : 4 dilution in 50 c.c. of solution (approximately 1 per cent of free acid) will absolutely prevent the precipitation of the cadmium upon the cathode (current, 3 ampères; E.M.F., 7·5 volts). If less nitric acid was used, traces of cadmium were deposited upon the cathode.

*Summary of Results obtained in the Estimation of Cadmium by means of the Rotating Cathode.*

The results of the work described in this and the previous papers upon the estimation of cadmium by means of the rotating cathode may be briefly summarised as follows:—Under the conditions used, cadmium taken in the form of the sulphate may be very accurately and satisfactorily estimated by deposition from solutions containing sulphuric acid, sodium acetate, and acetic acid, or potassium cyanide; but little less satisfactorily from solutions containing urea, formaldehyde, or acetaldehyde; and also with proper precautions, from solutions containing pyrophosphates, phosphates, tartaric acid, or formic acid. From solutions containing oxalates or oxalic acid, ammonium tartrate, or potassium formate, however, I was unable to obtain satisfactory deposits. When taken as the chloride, cadmium does not permit such a wide range of conditions. Nevertheless, from solutions of the chloride containing sulphuric acid or potassium cyanide, or the pyrophosphates, the metal is deposited in a form comparable with that obtained when cadmium sulphate is taken. Solutions of the chloride of cadmium to which is added hydrogen disodic phosphate gave less desirable results; while solutions containing urea, formaldehyde, or acetaldehyde gave deposits free from sponginess only after careful regulation of the conditions. In addition to the solutions containing the oxalates, oxalic acid, the formates, and the tartrates, negative results were given in the case of the chloride by solutions containing the acetates, formic acid, and tartaric acid. The nitrate of cadmium is ill-fitted for electrolytic estimation, the cyanide solution being the only one from which satisfactory results were obtained. From solutions containing 1 per cent or more of free nitric acid, the cadmium is not deposited by the current.—*American Journal of Science*, xx., p. 453.

## COLOUR REACTIONS OF CERTAIN ORGANIC COMPOUNDS.

By Prof. E. PINERUA ALVAREZ.

BY means of the new general reagent of the polyphenols and their isomers, the hydrate of sodium dioxide ($Na_2O_2 \cdot 8H_2O$) prepared from sodium dioxide ($Na_2O_2 = 2NaO$), pure ethyl alcohol ($D = 0{\cdot}797$), and cold water, we may identify the compounds of which we shall speak, by using a little porcelain capsule in which from 5 to 10 centigrms. of the body is placed, with 2 or 3 decigrms. of dioxide and 5 c.c. alcohol, and, after allowing the bodies to react for four to six minutes, adding 15 c.c. distilled water.

The colourations produced are the following:—

*Emodine.*—Intense pink colour, which becomes yellow with several drops of acetic acid.

*Chrysarobine.*—Wine colour, which persists when water is added. With acetic acid it also becomes yellow.

*Dioxyanthraquinone*-1 . 2.—Beautiful violet-blue colour, which persists on adding water. On immersing the capsule in the liquid and blowing, the edges of contact become red. With acids, the liquid acquires an intense yellow colour.

*Alizarin.*—Violet colouration, becoming orange with acids.

*Trioxyanthraquinone* - 1 . 2 . 4. — Intense red - violet, changing to cherry-red on addition of water.

*Chrysophanic Acid.*—Cherry-red colour which with water becomes brighter.

*Rosolic Acid.*—Intense purple colour, which persists with water.

*Purpurine-alizarin.*—Intense and very beautiful pink colour, which persists on adding water.

*Anthrogallol.*—Dark blue colour, almost black, unchanging.

*Dioxyquinone.*—Brown-yellow colour, changing to red with water.

*Ellagic acid.*—Brown-black colour, becoming yellow with addition of water.

* Note presented at the Sixth International Congress of Applied Chemistry, held at Rome, 1906.

## ADOPTION OF A SYSTEM OF NOMENCLATURE FOR DESIGNATION OF THE CONDENSED INORGANIC COMPOUNDS.*

By Prof. E. PINERUA ALVAREZ.

I HAVE the honour of proposing to the Congress the adoption of a system of nomenclature for distinguishing clearly and simply numerous and important *condensed inorganic compounds*, which have no name or are improperly named.

We frequently find that many molecules of the same acid unite and condense into a single one, originating a series of other acids of different properties (polymers), to which is given a distinct name, formed by placing before the fundamental, simple or not condensed, the prefixes *mono*, *di*, *tri*, *tetra*, *penta*, *hexa*, &c.

We say, for example, *dimetaphosphoric*, *trimetaphosphoric*, *tetrametaphosphoric*, *hexametaphosphoric acid*, names expressing that these bodies are formed by *two*, *three*, *four*, *or six molecules* condensed into one, of the acid $HPO_3$, *metaphosphoric*.

Whilst keeping this method of nomenclature for those bodies only which result from *simple condensation*, our proposal will serve to designate compounds of complex function, both anhydrides and acids, *resulting from the condensation of an acid with simultaneous elimination of one or several molecules of water*. It could also be applied to the corresponding metallic derivatives.

The system consists simply in adding to the specific name of the condensed acid a number expressing the molecules of water eliminated.

Thus, for example, the compound $Mn_2O_5H_2$, resulting from the condensation of 2 mols. of manganous acid with elimination of one of water, $2MnO_3H_2 - H_2O = Mn_2O_5H_2$, and has actually no name, should be called *dimanganous acid*-1, and its metallic derivative, $Mn_2O_5K_2$, *potassium dimanganite* 1.

The compounds $Mn_4O_{10}H_3K$ and $Mn_5O_{11}K_2$, derived respectively from the acids *tetramanganous*-2 *and pentamanganous*-4, according to the following equations:—

$$4MnO_3H_2 - 2H_2O = Mn_4O_{10}H_4,$$
$$5MnO_3H_2 - 4H_2O = Mn_5O_{11}H_2,$$

will be called *monopotassium tetramanganite*-2 *and potassium pentamanganite*-4.

By adopting this system, ordinary ammonium molybdate, $Mo_7O_{24}(NH_4)_6$, derived from the acid heptamolybdic-4, $7MoO_4H_2 - 4H_2O = Mo_7O_{24}H_6$, will be called ammonium heptamolybdate-4.

* Note presented at the Sixth International Congress of Applied Chemistry, held at Rome, 1906.

Borax derived from the *acid tetraboric*-5 will receive the name sodium *tetraborate*-5, $4BO_3H_3—5H_2O = B_4O_7H_2$.

By the same reasoning, the compound derived from the acid $S_2O_5H_2$, disulphurous-1, will be called *disulphites*-1, and the pyrosulphates, pyrophosphates, pyroarseniates, pyrantimoniates, &c., will be called disulphates, diphosphates, diarseniates, diantimoniates-1.

The compound $S_4O_{13}H_2$, discovered by Weber, which which has no name, will be, according to this system, the acid *tetrasulphuric*-3, $4SO_4H_2—3H_2O = S_4O_{13}H_2$, and $S_4O_{15}H_6$ will be the acid *tetrasulphuric*-1,—

$$4SO_4H_2—H_2O = S_4O_{15}H_6.$$

The same system will apply to the numerous polyiodic, polyperiodic, polysulphurous, polyphosphorous, polyphosphoric, polysilicic, polystannic, polyniobic, polytantalic, polymolybdic, polytungstic, &c., compounds.

I would ask the Congress for an opinion on this proposition.

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NOTE ON THE

## ESTIMATION OF NIOBIUM AND TANTALUM IN THE PRESENCE OF TITANIUM.

By C. H. WARREN.

THE obtaining of a strong reaction for niobium in the mineral described in a previous paper and the failure to obtain more than a fraction of a per cent of niobium by means of the acid potassium sulphate fusion and leaching in cold water, naturally led to an examination of the methods for estimating these elements quantitatively in the presence of each other.

So far as the writer can ascertain, the most common method followed is that involving a fusion with bisulphate of potash followed by leaching with cold water, these operations being repeated until all the titanium has passed into solution, while the niobic and tantalic oxides remain behind. Dr. A. A. Noyes states that when treated in this manner fairly large quantities of niobium and tantalum pass into solution with titanium when much of the latter is present ("System of Qualitative Analysis," *Technology Quarterly*, 1904, xvii., No. 3, p. 218: CHEMICAL NEWS, xciii., p. 134 *et seq.*). With this statement in mind a few experiments were made to gain some further idea of the magnitude of the error involved in the method.

Pure $TiO_2$ was prepared from selected crystals of rutile by the usual chemical methods. $Nb_2O_5$ and $Ta_2O_5$ were prepared from the columbite of Branchville, Conn., after the method described by Osborne (*Am. Journ. Sci.*, 1885, [3], xxx., 330), except that the precipitated oxides were digested for some time with ammonium sulphide to insure the removal of any tungsten or tin which might be present. The final products were subjected to the most careful qualitative examination, and no impurity other than a trace of iron could be detected.

The attempts at separating these oxides, quantitatively, when mixed together were very unsatisfactory, and although few in number seem to thoroughly confirm Dr. Noyes's statement. Indeed, considerable quantities of niobium may be made to pass into solution with the titanium, as the figures given below show. In the first three experiments, the fusion and leachings were thrice repeated. In each case the fusion was mashed to a powder under cold water in an agate mortar, and allowed to stand with from 250 to 300 c.c. of water for twenty-four hours. The titanium was precipitated from the combined filtrates with ammonium hydroxide, filtered, washed free from sulphates, and ignited to a constant weight. The residues from the first two leachings gave a strong reaction for titanium with hydrogen peroxide, and a small amount of titanium always remained n the last residue.

| No. | $Nb_2O_5$—$Ta_2O_5$ (about 3 : 1) taken. | $TiO_2$. | Weight of oxides extracted. | Excess. |
|---|---|---|---|---|
| 1. | 0·2500 | 0·2359 | 0·3046 | 0·0687 |
| 2. | 0·2103 | 0·2039 | 0·2580 | 0·0541 |
| 3. | 0·3031 | 0·2698 | 0·2883 (*b*) | 0·0185 |
| 4. | 0·0178 (*a*) | 0·3605 | 0·0010 (*c*) | — |

(Weights in grm.)

(*a*) $Nb_2O_5$ only.
(*b*) Still gave a strong reaction for titanium.
(*c*) Niobium undissolved.

From No. 4 it would appear that as much as 5 per cent of niobium may pass into solution with an excess of titanium, and thus be practically lost in the course of analysis. Although further study of the most favourable conditions of fusion and solution might be of interest in themselves, the method appears to offer little chance of being modified so as to give more than roughly approximate results.

The method proposed by T. B. Osborne was next examined ("The Quantitative Estimation of Niobium," *Am. Journ. Sci.*, 1885, [3], xxx., pp. 328—337). This depends on the titration of a solution containing the titanium and niobium in the lower state of oxidation with potassium permanganate, thus oxidising these elements to the higher oxides, and the subsequent estimation of titanium colorimetrically, while any tantalum, which is not reduced to the lower oxide, present in the original sample, is found by difference. The method of procedure is briefly this:—The mixture of the three acids, tantalic, niobic, and titanic, is dissolved in hydrofluoric acid, and the excess of acid expelled on the water-bath. The fluorides thus obtained are dissolved in concentrated hydrochloric acid, washed with the same acid into a 100 c.c. flask (total volume about 50 c.c.), and reduced for three-quarters of an hour with amalgamated zinc and a piece of platinum-foil in an atmosphere of carbon dioxide at a temperature of 80° C. The reduced solution is cooled thoroughly, diluted with freshly boiled cold water to about 350 c.c., and titrated with permanganate. To this solution ammonia is added in slight excess, the precipitate formed, just dissolved in sulphuric acid, and the volume made up to exactly 500 c.c. The titanium is then estimated colorimetrically, with hydrogen peroxide in 50 c.c. portions of this solution.

For any except small amounts of titanium the colorimetric method is open to the serious objection that any error in estimating the amount of titanium in the aliquot portion (and that error can hardly fail to be considerable where a large amount of titanium is present) is multiplied by ten in estimating the total amount present. Mr. Osborne gives the result of only a single application of the method. The figures are as follows:—

| | $Nb_2O_5$. | $Ta_2O_5$. | $TiO_2$. |
|---|---|---|---|
| Taken .. .. | 0·3357 | 0·2246 | 0·0687 |
| Found .. .. | 0·3314 | 0·2289 | 0·0667 |

(Weights in grm.).

The agreement here is quite satisfactory, but as the relative amount of titanic oxide is small, and as the writer had never had any experience with the method, it was decided to make a trial of the method before using it in an analysis. In Experiments 1 to 4 of those given below Mr. Osborne's directions were followed closely. In Nos. 5 and 6 the time of reduction was increased, and in No. 6 the volume of acid was doubled. One other experiment was tried, and the temperature raised to nearly 100° C.; but as a separation of the metallic acids took place this one is not included. The results obtained by reduction and titration are as shown in Table (see next column).

The large size and irregularity of the resulting errors led the writer to abandon further work on the method with the conclusion that it is wholly unsatisfactory as it stands. One source of error in the method is possibly the loss of some volatile, metallic fluoride during the removal of the

Time of reduction: Nos. 1—4, three-quarters of an hour; Nos. 5 and 6, one hour.
Temperature: 80° C.
Volume: Nos. 1—5, 50 c.c.; No. 6, 100 c.c.
Weights in grms.

| No. | $Nb_2O_5$. | $Ta_2O_5$. | $TiO_2$. | $KMnO_4$ required. | $KMnO_4$ used. | Differences. |
|---|---|---|---|---|---|---|
| 1. | 0·2163 | 0·1649 | 0·2453 | 0·1988 | 0·1450 | −0·0540 |
| 2. | 0·2034 | 0·1062 | 0·2083 | 0·1783 | 0·1551 | −0·0232 |
| 3. | 0·2067 | 0·1090 | 0·0708 | 0·1254 | 0·1138 | −0·0116 |
| 4. | 0·2283 | 0·1054 | 0·2079 | 0·1899 | 0·1630 | −0·0269 |
| 5. | 0·1889 | — | 0·1933 | 0·1565 | 0·1317 | −0·0248 |
| 6. | 0·2140 | — | 0·2033 | 0·1814 | 0·1620 | −0·0183 |

hydrofluoric acid on the water-bath. The addition of sulphuric acid with the hydrochloric in order to prevent such volatilisation is inadvisable, since, as Mr. Osborne states, the reduction of the niobium is then far from constant, and it may be added, the tendency of the metallic acids to precipitate during reduction would be greater.

There appears to be, so far as the writer can discover, no method by which more than a rough approximation toward a quantitative separation of these elements can be effected, notwithstanding the numerous analyses purporting to have accomplished a separation of sufficient accuracy to warrant considerable speculation as to the chemical constitution of the group of minerals containing these elements. The problem of their separation is an extremely interesting one mineralogically as well as chemically, since the constitution of so many highly interesting minerals depend on its successful solution. The increasing use of tantalum in lamps and perhaps in other ways, and its common occurrence with niobium and titanium, make a satisfactory quantitative separation of these elements highly desirable, and it is to be hoped that it may soon be realised.—*American Journal of Science*, [4], xxii., No. 132.

## VOLUMETRIC METHOD POR THE ESTIMATION OF CARBON IN IRON AND STEEL WITH THE USE OF BARIUM HYDOXIDE.*

By JAMES A. AUPPERLE.

The method which I am about to describe has been found to compare very favourably with results obtained by gravimetric methods, with the advantage of being more rapid. It is based upon the following data:—

*First.*—Barium hydroxide can be titrated with acids in the presence of barium carbonate (which is neutral or faintly alkaline to phenolphthalein), and no carbonic acid will be lost.

*Second.*—Carbonic acid is indicated by phenolphthalein, and when any barium carbonate is dissolved by standard acid during titration, the fact will be shown by the change in colour.

*Third.*—Barium hydroxide can be titrated with acids without filtering off the barium carbonate, providing the acid is run into the mixture by a prolongation of capillary tube attached to the burette and extending well into the solution that is being titrated.

The reason for using the capillary tube is that if any carbonic acid be liberated in the lower portion of the beaker, it would be reabsorbed by the upper portion containing barium hydroxide.

Hydrochloric acid has been found to give the best results, and an acid a trifle less than N/5 is used. This is prepared by mixing 15 c.c. of acid (1·20) and 1000 c.c. of water. One c.c. will approximately equal 0·001 grm. carbon.

The barium hydroxide solution is prepared from 31·5 grms. of Merck's crystallised salt, $Ba(OH)_2 8H_2O$, dissolved in 1000 c.c. of boiled water. When both acid and alkali are at room temperature, and without waiting for the suspended barium carbonate to settle completely, a measured portion is titrated with acid, and the remaining barium hydroxide is then diluted with water, so that 1 c.c. = 1 c.c. of acid. The barium hydroxide is then allowed to stand until clear, and again titrated with acid.

The phenolphthalein solution is 1 to 30 of alcohol, and as it usually contains acid, it is rendered pink with dilute caustic soda or potash. Three drops of phenolphthalein are used for each titration.

When sulphuric or oxalic acid is used for titrating, the barium sulphate or oxalate formed in addition to the barium carbonate present, renders them less desirable than hydrochloric acid, which forms no precipitate.

In using this method in connection with burning steel filings in a current of oxygen, an accurate determination of carbon can be made in twenty minutes, which includes the time consumed in filing the steel.

I have found that filings carefully taken check well in carbon, as found in borings secured in the usual manner, with the advantage that an ignition can be made at a lower temperature and in less time.

The following table will show how the time is distributed in making a direct combustion:—

| | Minutes. |
|---|---|
| Filing the sample .. .. .. .. .. .. .. | 4 |
| Weighing sample and placing dish in Aupperle combustion crucible .. .. .. .. .. .. .. | 2 |
| Measuring barium hydroxide, attaching Meyer tube to combustion apparatus, starting oxygen, and lighting gas .. .. .. .. .. .. .. .. | 3 |
| Ignition of borings .. .. .. .. .. .. .. | 8 |
| Emptying, washing bulb, and titrating .. .. .. | 3 |
| | 20 |

In filing the sample, a large file which has been previously cleaned with a stiff brush is used. The filings are weighed and placed in a platinum dish that fits the Aupperle crucible. This dish contains a one-eighth inch layer of 120 mesh emery, which is heavier than the precipitated alumina ordinarily used and is not so easily projected out of the dish.

The platinum dish is covered with a disk of platinum foil perforated in two semi-circles which form wings, one bent into and the other out of the dish. The wings are bent at angles of 45°, which prevent anything being projected out of the dish.

I have found that with two ounces of gas pressure and gas averaging 700 B.T.U. per cubic foot the crucible becomes white hot, and steel filings are completely oxidised in eight minutes. A Bunsen vertical blast-lamp gives good satisfaction.

At least twenty pounds of air pressure should be used. A single cylinder compressor making 150 revolutions per minute gives enough air for two lamps. By simply closing the valve through which the air enters the pump, a five-pound vacuum can be maintained and used for suction filtering.

Mr. Philo Kemery, of the Crescent Steel Works, Pittsburg, devised the spiral educt tube of the Aupperle crucible which I have adopted and found very satisfactory. The present form of the crucible has one coil of the educt tube around the crucible and joined to the side instead of the bottom. This permits more heat to be concentrated on the bottom of the crucible, and the educt tube becomes hot enough to oxidise all carbon to carbon dioxide.

The standard barium hydroxide and standard acid are contained in bottles holding twelve litres, each bottle being supplied with compressed air in order to facilitate rapid measuring.

The air that enters the barium hydroxide bottle is passed through a solution of caustic potash.

The capillary tube attached to the burette stop-cock is about five inches long.

* Read before the Indiana Section of the American Chemical Society at Lafayette, Ind., May 12, 1906. From the *Journal of the American Chemical Society*, xxviii, No. 7.

For carbon determinations in steel 75 c.c. of barium hydroxide are used, but for iron 150 c.c. contained in two Meyer tubes should be used, each containing 75 c.c. The second tube will only show a precipitate of barium carbonate when a very rapid current of oxygen gas is used, or when the sample is extremely high in carbon. Iron borings should be ignited for twelve to fifteen minutes, and the oxide of iron remaining in the dish should be fused into one globule. The original shape of the borings should then have entirely disappeared.

The barium hydroxide and carbonate are poured into a beaker, and the Meyer tube rinsed three times with boiled distilled water. Three drops of phenolphthalein indicator are added and standard acid run in very rapidly until the red colour disappears and the white barium carbonate is seen. The beaker is then removed and placed under a burette containing standard barium hydroxide, which is added slowly, and until the original red colour returns. The number of cubic centimetres barium hydroxide used in titrating back is subtracted from the acid burette reading. Only about 1 c.c. is usually required.

In experimenting to find how much carbon dioxide would be lost by adding sufficient standard acid to dissolve all the barium carbonate, and immediately titrating back with barium hydroxide, 75 c.c. of acid were added to the mixture of barium hydroxide and carbonate from a 0·90 per cent carbon steel, and on titrating back to original pink 0·88 per cent was found, thus showing practically no loss of carbon dioxide even when all barium carbonate is dissolved.

The acid is standardised with steel or iron of known carbon content. For steel the theoretical value may be used, 1 c.c. N/5 acid = 0·0012 grm. carbon. The following table shows how well the method checks with the gravimetric methods :—

*Weighing as* $BaCO_3$.

| | Gravimetric. | Volumetric. |
|---|---|---|
| | 3-Grm. samples. | 3-Grm. samples. |
| Steel standard .. .. | 0·090 | 0·090 |
| " .. .. | 0·115 | 0·113 |
| " .. .. | 0·380 | 0·393 |
| " .. .. | 0·643 | 0·627 |
| " .. .. | 0·735 | 0·725 |
| | 1-Grm. samples. | 1-Grm. samples. |
| " .. .. | 0·890 | 0·890 |
| " .. .. | 1·130 | 1·150 |
| " .. .. | 1·350 | 1·330 |
| Iron .. .. .. .. | 2·89 | 2·93 |
| " .. .. .. .. | 3·30 | 3·35 |
| International standard | 3·25 | 3·31 |
| " | 3·67 | 3·65 |
| Iron .. .. .. .. | 3·76 | 3·72 |
| " .. .. .. .. | 4·30 | 4·32 |

The following results are reported by Mr. J. C. Dickson of the Inland Steel Co., Indiana Harbor, Ind., to whom I extend thanks for investigating this volumetric method.

| | Gravimetric method by KOH. | Volumetric. |
|---|---|---|
| Steel .. .. | 0·463 | 0·460 |
| " .. .. | 0·890 | 0·896 |
| " .. .. | 0·934 | 0·929 |
| " .. .. | 1·097 | 1·101 |

To show that practically no barium carbonate dissolves during titration, several samples, after being titrated, were filtered and the barium carbonate weighed with the following results :—

*Carbon.*

| Volumetric method. | Gravimetric after titration. |
|---|---|
| 0·89 | 0·88 |
| 0·97 | 0·97 |
| 2·73 | 2·75 |
| 2·75 | 2·80 |
| 3·17 | 3·20 |
| 3·58 | 3·59 |
| 3·84 | 3·83 |

Many chemists prefer burning the carbonaceous residue, and I have found that graphite is rapidly oxidised if filtered on a small Gooch crucible, and then without drying or removing the asbestos, the Gooch is immediately placed *bottom up* in the combustion crucible. Fifteen minutes burning will be ample time, using about 60 c.c. oxygen gas per minute.

I wish to avail myself of this opportunity to thank Mr. H. A. Schwartz, the Secretary of the Indiana Section of the American Chemical Society, for investigating synthetic mixtures of various amounts of dried and also freshly precipitated barium carbonate, when mixed with various amounts of standard barium hydroxide and titrated with acid.

The Aupperle crucible is described in *Iron Age* of October 6, 1904; abstracted in *Iron and Steel Magazine*, December, 1904.

## PROCEEDINGS OF SOCIETIES.

### CHEMICAL SOCIETY.

*Ordinary Meeting, December 6th, 1906.*

Prof. R. Meldola, F.R.S., President, in the Chair.

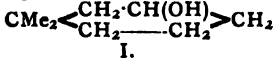
Certificates were read for the first time in favour of Messrs. George Bagley, Wellington, New Zealand; Frank Baker, B.Sc., St. John's School, Eton; Taylor Cook, B.Sc., 20, Sheddridge Street, Parson's Green, S.W.; Colin Ernest Dall, B.Sc., Maisonette, Maybury Road, Woking; Frederick Alldiss Eastaugh, Forty Hill, Enfield; Edward William Lanchester Foxell, B.Sc., 22, Grand Avenue, Muswell Hill, N.; William Howieson Gibson, B.Sc., 109, Brecknock Road, Holloway, N.; Christopher Maurice Walter Grieb, B.Sc., 33, Torrington Park, Finchley, N.; William Marrs Hooton, M.A., M.Sc., Repton, Burton-on-Trent; Arthur Vivian Hussey, Banthwaite, Belmont, Sutton, Surrey; Ernest Wilfrid Jackson, 65, Douglas Terrace, Middlesbro'; Albert Theodore King, B.Sc., Church Hill, Horsell, Woking; Joseph Martin, B.Sc., Coopers' Company's School, Bow, E.; Otto Oberländer, Ph.D., Chamber of Commerce Buildings, Oxford Court, E.C.; Frederic George Percy Remfry, B.A., D.Sc., Sunnymead, Tenby; Richard Noel Garrod Thomas, B.A., Balliol College, Oxford; Robert Burt Wight, M.A., 3, Clarendon Terrace, Linthorpe Road, Middlesboro'; Mark Arthur Wolff, 6, Hanover Terrace, Holland Park, W.

A ballot for the election of Fellows was held, and the following were subsequently declared duly elected:—Richard Abegg, Ph.D.; Paul Seidelin Arup, M.A.; William Heath Bayliss; Oscar Walter Bethea; James Spears Broome, B.Sc.; Thomas Henry Byrom; John Carmichael; Percy Henry Carpenter; Charles Taylor Cockburn; Reginald de Vere Cornwall; Hubert Frank Coward, M.Sc.; Henry Ernest Crocker; Archibald Prideaux Davson; James Herbert Dinwoodie; Charles George Edgar Farmer: Samuel Field; Anthony Nisbet Fitzgerald, B.A., B.Sc.; David Paton Grubb, B.Sc.; Octavius Hall, L.R.C.P., L.R.C.S.; John Hamer; H. Norman Hanson; Frederick James Harris; Charles Percy Hines, B.Sc.; Archibald McArthur Johnston; Edward Rees Jones; William Richard Simpson Ladell; David McIntosh, B.Sc.; Tarak Nath Majumdar; John Mastin; Alexander Edmund Middleton; Arthur Higgs Morris; George Naylor; Arthur Percival Newton, B.Sc.; Charles Harold Oxland, B.Sc.; Benjamin Dawson Porritt; Herbert Stanley Redgrove; Frederic Ion Richardson, B.A.; Reginald Ernest Robinson, B.A.; Gopal Chandra Sen, M.A.; John Lionel Simonsen, M.Sc.; Charles Smith; William R. R. Starling; Harry George Telling; Emmanuel Isaac Thorne; George Gordon Watt; Frederick William Watson, B.Sc.; Chr. Winther, Mag. Scient.

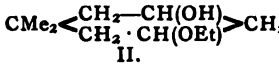
Of the following papers, those marked * were read :—

*212. "*Action of Reducing Agents on 5-Chloro-3-keto-1 : 1-dimethyl-$\Delta^4$-tetrahydrobenzene.*" By ARTHUR WILLIAM CROSSLEY and NORA RENOUF.

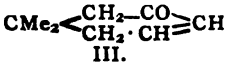
Experiments have proved that chloroketodimethyltetrahydrobenzene behaves in a varied manner towards reducing agents. Thus, sodium in moist ethereal solution (*Trans.*, 1905, lxxxvii., 1494) gives, as main product, 3-hydroxy-1 : 1-dimethylhexahydrobenzene (I.), whereas sodium in absolute alcoholic solution yields a small amount of this alcohol, and to a much larger extent 3-*hydroxy*-5-*ethoxy*-1 : 1-*dimethylhexahydrobenzene* (II.), as a colourless liquid boiling at 135°/25 m.m.



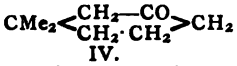
I.



II.



III.



IV.

When the chloroketone is treated with zinc filings in aqueous alcoholic solution, either in the cold or on heating, 3-*keto*-1 : 1-*dimethyl*-$\Delta^4$-*tetrahydrobenzene* (III.) is formed as a colourless liquid boiling at 88·5°/32 m.m., and possessing an odour of almonds and camphor. On the other hand, zinc dust in either glacial or dilute acetic acid gives rise to 3-*keto*-1 : 1-*dimethylhexahydrobenzene* (IV.), boiling at 77·5°/27 m.m., and having a pungent camphoraceous odour.

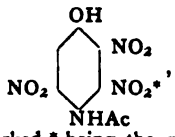
Characteristic derivatives of these various substances have been prepared, and in all cases their constitution has been conclusively proved by the oxidation products obtained from them.

In every reduction, dicyclic compounds are formed in addition to the simple ring compounds, and the following have been isolated, and were described together with some of their derivatives :—

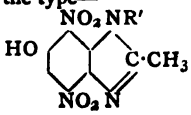
3 : 3'-*Diketo*-5 : 5 : 5' : 5'-*tetramethyl*-$\Delta^{1:1'}$-*di*cyclo*hexene* (m. p. 178°) ; 1 : 1'-*dihydroxy*-5 : 5 : 5' : 5'-*tetramethyl*-$\Delta^{2:2'}$-*di*cyclo*hexene* (m. p. 148°) ; 1 : 1'-*dihydroxy*-5 : 5 : 5' : 5'-*tetramethyldi*cyclo*hexane* (m. p. 212°) ; 3 : 3'-*dihydroxy*-5 : 5 : 5' : 5'-*tetramethyldi*cyclo*hexane* (m. p. 183°).

*213. "*A New Trinitroacetaminophenol and its Use as a Synthetical Agent.*" By RAPHAEL MELDOLA.

When diacetyl-*p*-aminophenol is nitrated by dissolving it in cold fuming nitric acid the first product is the mononitro-derivative, $C_6H_3(OAc)(NO_2)\cdot NHAc$ = 1 : 3 : 4, corresponding to the *m*-nitro-*p*-aminophenol of Hähle (*Journ. Prakt. Chem.*, 1891, [ii.], xliii., 63 ; Reverdin and Bucky, (*Ber.*, 1906, xxxix., 2687). This mononitrodiacetyl compound can be further nitrated by dissolving it in a mixture of fuming nitric and strong sulphuric acids, when a *trinitroacetaminophenol* is produced which forms the subject of the paper communicated by the author. This trinitro-derivative, which has not hitherto been described, is remarkably active as a synthetical agent owing to the extreme mobility of one of the nitro-groups. It crystallises in yellow needles melting with decomposition at 178—179°. The constitution is shown to be—



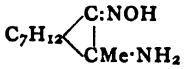
the nitro-group marked * being the mobile group. The action of various amines on the trinitro-compound has been studied, and the final products shown to be substituted benziminazoles of the type—



where R' is the radicle present in the amine used. In some cases substituted diaryl- or alkylaryl-amines are formed as intermediate products, and these undergo "anhydridisation" on heating or on treatment with dehydrating agents. The trinitro-compound reacts also with hydrazines and with certain phenolic substances, the investigation of the products being still in hand.

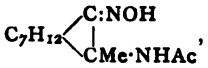
*214. "*Pinene Nitrolamine.*" By FREDERICK PEACOCK LEACH.

Pinene nitrosochloride, when allowed to remain at 45—50° with ammonia and alcohol, gives a well crystallised *nitrolamine*,—



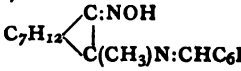
This compound melts somewhat indefinitely at 123—125°, contains approximately ½$H_2O$, and crystallises from alcohol in long silky needles.

The *hydrochloride*, *oxalate*, and *platinichlorides* have been prepared ; the *acetyl* derivative,—



crystallises in hexagonal prisms melting at 224° ; the *dibenzoyl* derivative melts at 167°, and the *diphenylcarbamide* at 133°.

Pinene nitrolamine reacts very readily with aldehydes, giving well crystallised condensation products ; the *benzylidene* derivative,—



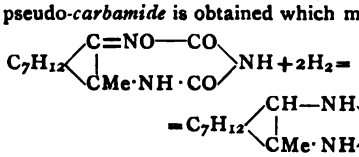
melts at 162° ; the *salicylidene* derivative at 128°, and the *furfurylidene* derivative at 164°.

With reducing agents either no action takes place or the amino-group is eliminated, giving rise to the ketone (Wallach's pinocamphone), which has been identified by means of its oxime melting at 86°.

*215. "*A Pseudo-semicarbazide from Pinene.*" By FREDERICK PEACOCK LEACH.

Potassium cyanate and pinene nitrosochloride interact in alcoholic solution, giving a *compound*, $C_{12}H_{17}O_3N_3$, the constitution of which is represented by the formula,—

it crystallises from alcohol in rosettes of prisms melting at 238—240°, dissolves in dilute alkalis, and gives alkali salts. When reduced with zinc dust and dilute acetic acid, a pseudo-*carbamide* is obtained which melts at 224° :—



Concentrated sulphuric acid gives pinene nitrolamine, carbon dioxide, and ammonia. The action of nitrous acid converts the *pseudo*-carbamide into a *nitroso*-compound, which crystallises from alcohol in yellow plates with a pink lustre and melting at 161° ; this on reduction gives a pseudo-*semicarbazide* melting at 209°, from which by the action of aldehyde and ketones several of the ψ-semicarbazones have been prepared and analysed.

216. "*Some Derivatives of Benzophenone. Synthesis of Substances occurring in Coto-bark.* (Preliminary Notice). By WILLIAM HENRY PERKIN, Jun., and ROBERT ROBINSON.

A mixture of veratryl chloride and pyrogallol trimethyl ether suspended in carbon disulphide reacts readily with aluminium chloride with the formation of 1 : 2 : 3 : 3' ; 4'-*pentamethoxybenzophenone*, $(MeO)_2C_6H_3\cdot CO\cdot C_6H_2(OMe)_3$, which crystallises from alcohol in prisms and melts at 125°. If, however, the reaction is prolonged, the product contains

*hydroxytetramethoxybenzophenone*, which crystallises in needles, melts at 115°, and is readily separated from the pentamethoxy-derivative on account of its solubility in alkalis.

When hydroxytetramethoxybenzophenone is treated with benzoyl chloride and caustic potash it yields a *benzoyl* derivative which crystallises from alcohol in stout, colourless prisms, melts at 149°, and is converted into pentamethoxybenzophenone when it is treated with methyl sulphate and caustic potash.

2 : 4 : 6 : 3′ : 4′-*Pentamethoxybenzophenone* (pentamethylmaclurin), $(MeO)_2C_6H_3{\cdot}CO{\cdot}C_6H_2(OMe)_3$, is obtained when aluminium chloride reacts with a mixture of veratryl chloride and phloroglucinol trimethyl ether in the presence of carbon disulphide. It melts at 156—to 157° and yields a *monobromo*-derivative (m. p. 144°) when its solution in chloroform is treated with bromine, and there can be no doubt that it is identical with the substance which Ciamician and Silber (*Ber.*, 1892, xxv., 1132) obtained from protocotoin, $CH_2{:}O_2{:}C_6H_3{\cdot}CO{\cdot}C_6H_2(OMe)_3$, by substituting two methyl groups for the methylene group.

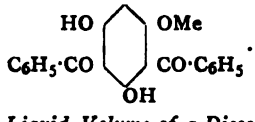
Since 2 : 4 : 6 : 3′ : 4′-pentamethoxybenzophenone is pentamethylmaclurin, many attempts were made with the object of converting it into maclurin itself, but so far without success.

3′ : 4′-*Methylenedioxy*-2 : 4 : 6-*trimethoxybenzophenone*, $CH_2{:}O_2{:}C_6H_3{\cdot}CO{\cdot}C_6H_2(OMe)_3$, was next synthesised by treating a mixture of piperonyl chloride and phloroglucinol trimethyl ether in carbon disulphide solution with aluminium chloride. The substance so obtained melted at 133° and was identical with the oxyleucotin of coto-bark, as was shown by a careful comparison of the two preparations and by the fact that when they were mixed in equal quantities the melting point was the same as that of the constituents.

When phloroglucinol monomethyl ether,—

$$C_6H_3(OMe)(OH)_2,$$

is treated with benzoyl chloride in the preseuce of zinc chloride, 2 : 4-*dibenzoxy*-6-*methoxy*-m-*phtholophenone*, $(C_6H_5{\cdot}CO)_2C_6H(OMe)(O{\cdot}CO{\cdot}C_6H_5)_2$, (m. p. 130—135°) is produced. This substance is readily hydrolysed by alcoholic potash with the formation of 2 : 4-*dihydroxy*-6-*methoxy*-m-*phthalophenone*, $(C_6H_5{\cdot}CO)_2C_6H(OMe)(OH)_2$, which melts at 187°, and is also produced when cotoin dibenzoate is treated with benzoyl chloride and zinc chloride. Its constitution must therefore be represented by the formula—




217. "*The Liquid Volume of a Dissolved Substance.*" By JOHN SCOTT LUMSDEN.

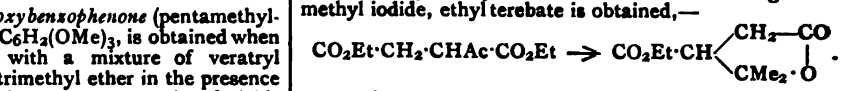
The values deduced for atomic volumes and atomic refractions from experiments made on pure liquids, hold with fair accuracy when applied to solids and liquids in solution; and the inference is that a liquid retains its own volume when dissolved, and that a solid assumes in solution the volume which the same weight of it would have if it existed as a liquid at the same temperature. If this inference is correct, a law of the "liquid volume" of a dissolved substance is made evident, and experimental results are recorded which prove that there is such a law which holds, not only for the volume assumed by a solid and liquid, but also for the volume occupied by a dissolved gas.

The law is expressed as follows:—When a substance in the liquid state dissolves without change of volume, the same substance when in the state of solid or gas will, when dissolved in the same solvent, change to the volume which the same weight of it would have if it were a pure liquid at the temperature of solution.

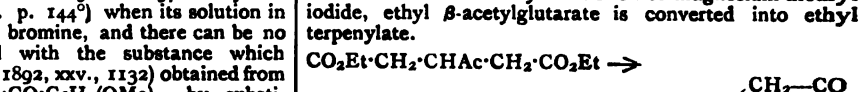
Irregularities are proved to be due to the experimentally ascertained facts that the volume in solution varies slightly with the solvent and with the degree of concentration of the solution, and also from the circumstance that when a liquid is dissolved there is often a slight alteration in volume, but the deviation from accuracy from these causes is so small that the law deserves recognition as a guide when problems relating to solution in non-dissociating solvents are being dealt with.

218. "*A Synthesis of Terebic, Terpenylic, and Homoterpenylic Acids.*" By JOHN LIONEL SIMONSEN.

When ethyl acetylsuccinate is treated with magnesium methyl iodide, ethyl terebate is obtained,—




In a similar manner by the action of magnesium methyl iodide, ethyl β-acetylglutarate is converted into ethyl terpenylate.

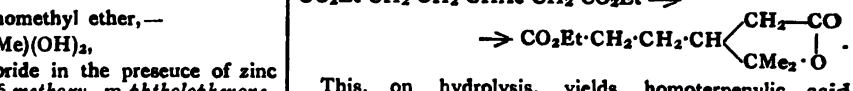



When the sodium derivative of ethyl acetylsuccinate is treated with ethyl β-iodopropionate, ethyl β-acetylbutane-αβδ-tricarboxylate,—

$$CO_2Et{\cdot}CH_2{\cdot}CH_2{\cdot}CAc(Co_2Et){\cdot}CH_2{\cdot}CO_2Et,$$

boiling at 200—201°/14 m.m is obtained.

This ester, when hydrolysed with concentrated hydrochloric acid, gives β-acetyladipic acid, $CO_2H{\cdot}CH_2{\cdot}CH_2{\cdot}CHAc{\cdot}CH_2{\cdot}CO_2H$, which melts at 102° and yields an ethyl ester boiling at 179°/18 m.m. which, when treated with magnesium methyl iodide, is converted into homoterpenylic ester.




This, on hydrolysis, yields homoterpenylic acid (m. p. 100—101°), which is identical with the homoterpenylic acid obtained by Baeyer (*Ber.*, 1896, xxix., 1919) by the oxidation of pinene.

219. "*Influence of Light on Diazo-reactions.*" Part I. By KENNEDY JOSEPH PREVITÉ ORTON, JOSEPH EDWARD COATES (and, in part, FRANCES BURDETT).

Solutions of diazonium salts in water, methyl or ethyl alcohol, acetic or formic acid, decompose rapidly on exposure to light, although in many cases they may be preserved for long periods if kept in the dark (compare *Proc.*, 1905, xxi., 168).

The product of the reaction depends on the solvent; in aqueous solution a phenol is formed; in methyl or ethyl alcohols, the corresponding phenyl, methyl, or ethyl ether is mainly produced, in some cases a certain amount of the diazonium salt being at the same time converted into hydrocarbon (replacement of the diazo-group by hydrogen); in acetic acid solution, a phenyl acetate is the sole product, but in formic acid, the change follows the equation: $Ar{\cdot}N(X){:}N + H{\cdot}CO_2H = ArH + N_2 + CO_2 + HX$.

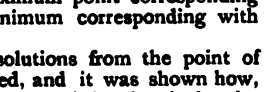
In most cases these reactions are quantitative; further, many diazo-compounds, which do not yield phenols, ethers, or phenyl acetates (for example, *s*-tribromodiazobenzene), when solutions in the appropriate solvents are heated, can be readily induced by light to undergo these changes.

Solutions of diazotates (*iso*diazotates) are not affected by light.

High concentrations of acid (for example 25 per cent sulphuric acid) do not appreciably affect the rate of decomposition of the diazonium salts. Exposure to light of solutions of diazonium sulphates in 95 per cent sulphuric acid brings about a conversion into the corresponding phenol.

These facts would appear to render untenable the view (Hantzsch) that phenols are formed from *syn*-diazohydroxides, since it is difficult to see how in such strongly

acid solutions there can be any hydrolysis of the diazonium salt and consequent formation of the diazonium hydroxide to allow of their presence, thus :—



220. "*The Viscosity of Liquid Mixtures.*" By ALBERT ERNEST DUNSTAN and ROBERT WILLIAM WILSON.

In continuation of previous work on this subject the authors have investigated the viscosity concentration curve of mixtures of water and sulphuric acid.

They find a well-defined maximum point corresponding with $H_2SO_4,H_2O$, and a minimum corresponding with $3H_2SO_4,2H_2O$.

The general behaviour of solutions from the point of view of viscosity was discussed, and it was shown how, from a knowledge of the viscosity and the chemical series to which it belongs, it is possible to determine the moleular weight of a liquid.

## NOTICES OF BOOKS.

*Numerical Tables and Constants in Elementary Science.* By SYDNEY LUPTON, M.A., F.C.S. London: Macmillan and Co., Ltd. New York: The Macmillan Company. 1906.

THIS collection of tables of scientific data is probably too well known to require recommendation, for it has been widely used now for more than twenty years In conciseness and completeness it is unique, and as it has recently been thoroughly revised it must be regarded as an indispensable part of the equipment of scientific libraries. The tables and miscellaneous data are classified according to the sciences with which they are connected, and as a good index is provided the book is very convenient for reference. The results of some of the most recent determinations of various constants are now included in an appendix, and many corrections and alterations have been made, while the full notes and references to standard works will give great assistance to those who wish to look up further information.

*A Method of Teaching Chemistry in Schools.* By A. M. HUGHES, B.Sc. (Lond.), and R. STERN, B.Sc. (Lond.). Cambridge: The University Press. 1906.

THERE is a great deal of good material in this book, and a teacher will get many hints from it, but at the same time the general plan advocated by the authors hardly seems satisfactory. For one thing, too many substances are introduced, and the arrangement is somewhat disjointed, while no single phenomenon is studied with anything resembling thoroughness. It is generally recognised that the aim of scientific teaching is the inculcation of a habit of thought, and this experience shows can only be effected by setting a high ideal of patience and accuracy before the learner. With a good teacher a detailed study of combustion, for instance, can provide material for weeks of work, with the short time usually allotted to science, and at the end of that period the child should have gained some idea what research means, though it must be allowed that he would have very little acquaintance with most of the compounds with which he would meet according to this scheme. The arguing from known to unknown is of course a good feature of the book, but the earlier parts want much enlarging; for instance, no corrections for temperature and pressure in measuring gases are explained. Nevertheless, some of the experimental directions will suggest useful ideas for the arrangement of apparatus, and the introduction is worth the careful attention of teachers.

*Uber Kathodenstrahlen.* ("On the Cathode Rays"). By P. LENARD. Leipzig: Johann Ambrosius Barth. 1906.

THIS pamphlet contains the text of the Nobel Lecture delivered at Stockholm before the Royal Swedish Academy of Sciences in May, 1906, and gives an interesting historical review of the cathode rays. Those who wish to learn something of modern theories of the constitution of matter, radio-activity and the nature of the electrons, without going very deeply into the subject, will find this short lecture gives them exactly what they want—a clear and readable account of the development of our present ideas, in which the reader is supposed to possess the minimum of previous knowledge of physics and mathematics. The author has taken special care to refer to all publications which treat of recent advances, and expressly states that he has given special prominence to his own work and theoretical views, believing that be is thus considering the wishes of his audience; at the same time, he scrupulously ascribes the honour of discoveries to those whose right it is to receive it. Altogether it would be difficult to find a more interesting and lucid discussion of the subject.

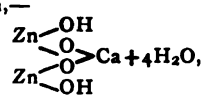
## CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Academié des Sciences.* Vol. cxliii., No. 23, December 3, 1906.

**The Reduction of the Oxide of Chromium by Boron.**—Binet de Jassonneix.—Former experiments have shown that when chromium is heated with boron in the electric furnace in a charcoal crucible, a fused body results, containing the definite boride CrB; and according to all of these, the compound exhibited great resistance to chemical reagents. The author obtained very different results by reducing the oxide of chromium with boron in the electric furnace, in crucibles of magnesium. The process gives fused products of variable composition, containing the definite boride CrB, which represents the limit of saturation of chromium by boron. All the products are attacked by hydrofluoric, hydrochloric and sulphuric acids, with formation of boric acid; nitric acid and solutions of the alkalis produce no effect. They can be oxidised at a high temperature by the fused alkalis or alkaline carbonates. Analysis shows that the content of CrB in the products obtained varies from 5 per cent to 17 per cent, and there is also boron in the state of the carbide.

**A very Sensitive Method of Precipitating Zinc.**—Gabriel Bertrand and Maurice Javillier.—The method originated in an observation, which led one of these authors, in 1892, to prepare crystalline compounds of zinc oxide with the metals of the alkaline earths. A crystalline deposit was obtained by distilling the commercial liquid ammonia with soapmakers' alkali, which proved to be zincate of calcium,—



the probability being that the zinc arose from the soda-lye. This production of zincate of calcium seemed to afford a very sensitive means of detecting zinc; zincate of calcium was prepared by adding excess of ammonia to a solution containing zinc and calcium, boiling, and allowing to stand till the crystals were deposited; these are so little soluble in the presence of lime, that even traces of zinc contained in a large quantity of liquid can be extracted; the calcium was precipitated as oxalate, and the zinc remaining in solution was converted into sulphate and weighed. The results obtained showed that the zinc recovered at the end of the experiment was from 88 to 97 per cent of the amounts

originally introduced. The new method therefore yields zinc almost quantitatively from very dilute solutions.

**The Etherification of Arsenious Anhydride by the Alcohols and Phenol.**—V. Auger.—This research followed upon the observation that arsenious anhydride is not volatile with water vapour, whilst it passes over in considerable quantity with the vapour of methyl alcohol, the explanation of which phenomenon seemed to point to the formation of a methyl-arsenious ether. The author has already demonstrated that arsenic acid heated with glycerine readily furnishes an arseniate, very unstable in the presence of water; and it seemed probable that the simple alcohols would act similarly with arsenious anhydride, but furnishing very little of the ether, in consequence of the hydrolysing action of the water formed during the process. The alcohol was heated with excess of crystallised arsenious anhydride, and the arsenic remaining in the liquid unchanged estimated with iodine. In this way were obtained the arsenites of the following alcohols: methyl, ethyl, propyl, isopropyl, butyl, isobutyl, and isoamyl.

**Condensation of Oxalacetic Ether with Cyanacetic in presence of Piperidine.**—Ch. Schmitt.—The author has previously described the conditions of studying the condensing action of the amines upon the cyanacetic ethers in presence of the ketone ethers (*Comptes Rendus*, cxl., p. 1400, May 22, 1905). Continuing the investigation, he has produced the crystalline body $C_{13}H_{17}O_6N$. It arises according to the following equation :—

$$\begin{array}{l} CH_2\text{———}C \\ | \qquad\quad | \\ CO_2C_2H_5 \quad CO_2C_2H_5 \end{array} + \begin{array}{l} CH_2\text{—}CN \\ | \\ CO_2C_2H_5 \end{array} = H_2O + \begin{array}{l} CH_2\text{———}C\text{═══}C\text{—}CN \\ | \qquad\quad | \qquad\quad | \\ CO_2C_2H_5 \quad CO_2C_2H_5 \quad CO_2C_2H_5 \end{array}.$$

which is ethyl cyanopropenetricarboxylate. It is a neutral body, losing $CO_2$ under the action of acids and alkalis. but forming no definite product. This differs from a body of the same empirical formula, described by J. Errera and E. Perciabosco as a heavy yellow oil with an acid reaction. A new synthesis of the latter has thrown light upon its constitution. Ethyl oxalacetate reacts upon ethyl sodium cyanacetate, according to the following equation :—

$$\begin{array}{l} CN\text{—}C\text{—}NaH \\ | \\ CO_2C_2H_5 \end{array} + \begin{array}{l} COH\text{———}CH \\ | \qquad\quad | \\ CO_2C_2H_5 \quad CO_2C_2H_5 \end{array} = H_2O + \begin{array}{l} CN\text{—}CNa\text{———}C\text{═══}CH \\ | \qquad\quad | \qquad\quad | \\ CO_2C_2H_5 \quad CO_2C_2H_5 \quad CO_2C_2H_5 \end{array},$$

and the latter body loses its nitrite group, when treated with hydrochloric acid, giving rise to aconitic acid. To sum up; two distinct derivatives of cyanacetic ether exist, of formula $C_3H_{17}O_6N$; the one has an acid reaction, and corresponds to the formula—

$$\begin{array}{l} CN\text{—}CH\text{———}C\text{═══}CH \\ | \qquad\quad | \qquad\quad | \\ CO_2C_2H_5 \quad CO_2C_2H_5 \quad CO_2C_2H_5 \end{array},$$

and the other is a neutral body of the formula—

$$\begin{array}{l} CH_2\text{———}C\text{═══}C\text{—}CN \\ | \qquad\quad | \qquad\quad | \\ CO_2C_2H_5 \quad CO_2C_2H_5 \quad CO_2C_2H_5 \end{array}.$$

**Replacement of the Hydroxyl of certain Carbinols by the Radical** $—CH_2CO_2H$.—R. Fosse.—The hydroxyl of the secondary aromatic carbinols, substituted by the residues $CH_3—O$, $CH_2<^{O}_{O}$, $^{CH_3}_{CH_3}>N$, is readily replaceable by the ethyl radical, $—CH_2—CO_2H$. These hydroxyl compounds and malonic acid give up 1 molecule of water and of $CO_2$, producing a new series of propionic acids, substituted in $\beta$ :—

$$>CHOH + CH_2<^{CO_2H}_{CO_2H} = H_2O + CO_2 + >CH—CH_2—CO_2H.$$

This is a new reaction, resembling the well-known one of the aldehydes and malonic acid, which leads to the propionic acids substituted in $\beta$ :—

$$—C\overset{H}{=}O + CH_2<^{CO_2H}_{CO_2H} = H_2O + CO_2 + —C\overset{H}{=}CH—CO_2H.$$

The author then gives an account of several $\beta\beta$-propionic acids prepared by him according to this method.

## MISCELLANEOUS.

**Institute of Chemistry.—Examination in Biological Chemistry, October 23rd to 26th, 1906.—Two Associates examined for the Certificate passed—Robert William Clarke, A.I.C.; Reginald Mead Filmer, B.Sc. (Lond.), A.I.C. Two Candidates examined for the Associateship passed—Conrad Theodore Gimingham, University College, London; Wilfred Ambrose Whatmough, King's College, London, and under A. H. M. Muter, F.I.C.**

**Carbohydrates of Tea.**—A. D. Maurenbrecher and B. Tollens.—The dried substance contains an average of 5·60 per cent of pentosan.—When the caffeïn is removed by extraction with water, traces of fructose are found in the syrup thus obtained, and also glucose, Hydrolysis of the residue from the extraction with water revealed the presence of arabinose and galactose.—*Berichte*, xxxix., No. 14.

## MEETINGS FOR THE WEEK.

THURSDAY, 27th. SATURDAY 29th. } Royal Institution, 3. (Christmas Lectures, adapted to a Juvenile Auditory). "Signalling to a Distance, from Primitive Man to Radio-telegraphy" (Experimentally Illustrated), by W. Duddell, M.Inst E.E.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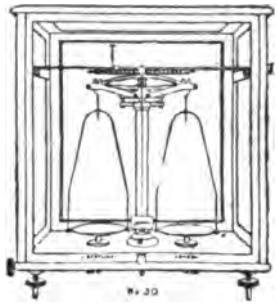

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## CALCIUM AS AN ABSORBENT OF GASES, AND ITS APPLICATIONS IN THE PRODUCTION OF HIGH VACUA AND FOR SPECTROSCOPIC RESEARCH.*

By FREDERICK SODDY, M.A.

By means of a special electric furnace, surrounded by a porcelain tube and enclosed within a glass tube, it has been found possible to heat reagents *in vacuo*, in sealed soft glass apparatus, to a far higher temperature than the softening point of glass. Calcium, heated in this manner, is, under suitable conditions, an absorbent of all the known gases, with the exception of those of the argon group. Provided the initial gas-pressure does not exceed a few millimetres of mercury, all the common gases are rapidly and completely absorbed by calcium between 700° and 800° C., and a vacuum attained through which the electric discharge cannot be forced. Arndt (*Ber.*, 1904, xxxvii., 4733), in an investigation of the melting-point of calcium, noticed that the calcium volatilised freely below its melting-point when heated in a vacuum, and the vapour reacted energetically with the oxygen and nitrogen of the residual air. He did not investigate the behaviour of other gases.

Barium and strontium behave in a manner very similar to calcium.

The high vacua readily produced by the absorption of residual gases by calcium are at least equal to the highest attained by any other process. By filling the apparatus with mercury after the action of the calcium, and compressing any residual gas several hundred times into a tiny spectrum tube, it was found that the vacuum was still so high that the spectrum tube was of high resistance and fluoresced brightly under the discharge. Since argon is not absorbed, the air must be first removed from the apparatus by means of a Fleuss pump, and by replacement of the last traces with some argon-free gas, before the calcium is brought into action. The condensed gases evolved from the apparatus on heating usually suffice to replace the last of the air during the mechanical exhaustion. The calcium, being a good conductor of electricity, may be readily heated to the required temperature within the sealed glass vessel by induction through the walls from an alternating circuit outside the vessel.

By admitting known volumes of air, and absorbing all but the argon, it was found that it was not possible to force a discharge through argon at a pressure less than 1/50 m.m. of mercury. At this pressure the orange and green lines of the spectrum became faintly visible, and at 1/25 m.m. the reds appeared. At ½ m.m. the spectrum tube had a resistance equivalent to 5 m.m. alternative spark-gap in air, and at 1 m.m. the tube was still brilliantly fluorescent. The other inert gases behave similarly. Helium is non-conducting below a pressure of 1/20 m.m. when pure, but in the presence of any common gas, as hydrogen or oxygen, one-hundredth of this amount serves to reveal the $D_3$ line. This behaviour of the inert gases explains why they appear to "run out" in spectrum tubes so quickly, for when the traces of common gases always present are absorbed by the electrodes, the inert gases are left in the pure and non-conducting state. The apparent ease with which high vacua are obtained by the use of cooled charcoal is misleading, for the atmospheric helium and neon, although not conducting the discharge, remain unabsorbed. To any but an electrical test "charcoal vacua," like "calcium vacua," are poor, unless precautions are taken to remove air before the absorption.

ADDENDUM.—*A Method of Gauging by Evaporation the Degree of High Vacua.*

By ARTHUR JOHN BERRY.

The attempt was made to use the rate of evaporation of liquid air in a Dewar bulb as an indication of the degree of vacuum therein. The same bulb was exhausted by three methods: (1) by the mercury pump; (2) by cooled charcoal from atmospheric pressure, using two successive quantities of charcoal; (3) by cooled charcoal after the air had been first removed by a pump. It was found that whereas the vacuum in (2) was inferior to that in (1), that in (3) was very much the best of the three.

* Abstract of a Paper read before the Royal Society, November 15, 1906.

## THE ESTIMATION OF CADMIUM AS THE OXIDE.

By CHARLES P. FLORA.

CADMIUM may be simply and accurately estimated by converting the carbonate to the oxide by ignition. The oxide of cadmium may be subjected to very intense heat without loss from volatilisation; but in the presence of any carbonaceous matter it is very easily reduced to the metal, which is quite volatile at high temperatures. Consequently, this method has always been subject to more or less change of error where paper-filters have been used. The usual course has been to wash thoroughly and then dry the precipitated carbonate, which is then removed as completely as possible from the filter; the latter then being burned separately. Even here there has always been a very appreciable loss, to avoid which various more or less complicated modes of treatment have been offered. As a type of these, we may take that of Max Muspratt (*Journ. Soc. Chem. Ind.*, 1894, xiii., 211), who, after noting that high results were given by the ignition of the nitrate formed by dissolving the precipitated carbonate in nitric acid on account of included sulphate, proceeded as follows:—The precipitated carbonate was washed and dried, and as completely as possible scraped free from the filter-paper, and then converted to the oxide by gentle ignition. This carbonate was entirely free from sulphate. The filter-paper was treated with nitric acid, and the resulting solution and rinsings brought into a large porcelain crucible and evaporated to dryness. The dry nitrate was gently heated, and the weight of the oxide obtained added to that of the mass of the precipitate. Even after this tedious procedure, Muspratt is obliged to suggest that the results would be more satisfactory if the oxide obtained by the ignition of the paper and the residues upon it be calculated as $Cd_2O$ rather than CdO. Evidently the method would give satisfactory results if this reducing action of the filter could be avoided, and in former papers from the Kent Chemical Laboratory of Yale University, it has been shown that this may be accomplished by the use of asbestos filters in a Gooch crucible (see Browning, *Am. Journ. Sci.*, 1893, [3], xlvi., 280; Browning and Jones, *Ibid.*, 1896, [4], ii., 269). There is then no danger of loss from reduction, and the carbonate method is simplified and placed among the good analytical methods. Recently, however, Miller and Page (CHEMICAL NEWS, 1901, lxxxiv., 312) have found that "the carbonate method is the most troublesome and the least satisfactory"; but these investigators did not use the asbestos filter.

The work of the writer upon the carbonate method fully substantiates the previous work from this laboratory. For the determinations given, a solution of cadmium sulphate was used, whose standard was accurately given by the

average of a large number of closely agreeing electrolytic determinations. Portions of this solution were accurately measured from a burette and diluted to 300 c.c. with hot water. A 10 per cent solution of potassium carbonate was then added, drop by drop, with constant stirring until no further precipitation took place. The whole was then boiled for about fifteen minutes, when the precipitate became granular and quickly settled. It was then filtered upon an asbestos mat in a Gooch crucible, which had previously been ignited and weighed, and was then carefully washed with hot water. In several cases, washing by decantation was used. The precipitate was then dried and ignited over a Bunsen burner, first gently, then at full red heat until a constant weight was obtained, care being taken to avoid the reducing action of any unburned gas from the burner. The following results were obtained :—

| No. | CdO taken. | CdO found. | Error. |
|---|---|---|---|
| | Grm. | Grm. | Grm. |
| 1. | 0·1277 | 0·1275 | −0·0002 |
| 2. | 0·1277 | 0·1280 | +0·0003 |
| 3. | 0·1277 | 0·1272 | −0·0005 |
| 4. | 0·1399 | 0·1391 | −0·0008 |
| 5. | 0·1399 | 0·1399 | 0·0000 |
| 6. | 0·1703 | 0·1700 | −0·0003 |
| 7. | 0·1703 | 0·1700 | −0·0003 |
| 8. | 0·2129 | 0·2128 | −0·0001 |
| 9. | 0·2129 | 0·2128 | −0·0001 |
| 10. | 0·2554 | 0·2554 | 0·0000 |

The method is simple in execution, and the above results prove its accuracy.

Some of the older manuals also give as a method for the estimation of cadmium that of igniting to the oxide the precipitated hydroxide obtained by adding a solution of sodium or potassium hydroxide to the solution containing the salt of cadmium. Follenius (*Zeit. Anal. Chem.*, 1874, xiii., 284) has published some results obtained with the use of an asbestos filter, and it was decided to try this method in comparison with the carbonate method. As in the experiments with the carbonate, portions of the solution of cadmium sulphate were carefully measured off from a burette, diluted to about 300 c.c., and heated to boiling. A 10 per cent solution of potassium hydroxide was then added drop by drop and the whole boiled for about fifteen minutes. Upon cooling, the precipitation quickly settled in a semi-granular state, and was best filtered and washed by decantation. The results were lower than when the cadmium was precipitated as the carbonate, as is shown by the following table :—

| No. | CdO taken. | CdO found. | Error. |
|---|---|---|---|
| | Grm. | Grm. | Grm. |
| 1. | 0·1277 | 0·1277 | 0·0000 |
| 2. | 0·1277 | 0·1270 | −0·0007 |
| 3. | 0·1277 | 0·1260 | −0·0017 |
| 4. | 0·1277 | 0·1286 | +0·0009 |
| 5. | 0·1362 | 0·1350 | −0·0012 |
| 6. | 0·1399 | 0·1389 | −0·0010 |
| 7. | 0·1703 | 0·1697 | −0·0006 |
| 8. | 0·1403 | 0·1693 | −0·0010 |
| 9. | 0·1703 | 0·1699 | −0·0004 |
| 10. | 0·1788 | 0·1802 | +0·0014 |
| 11. | 0·2129 | 0·2139 | +0·0010 |
| 12. | 0·2129 | 0·2128 | −0·0001 |

While the figures show that fair results may be obtained by the hydroxide method, it can be compared with the carbonate method neither for accuracy nor convenience; the precipitate does not attain the same granular form as that of the carbonate; it is hard to filter, difficult to wash, and can be removed completely from the beaker in which precipitation takes place only with the utmost difficulty.—*American Journal of Science*, xx., p. 456.

## REACTION OF SALTS OF COBALT OF SERVICE IN ANALYTICAL CHEMISTRY.*

By Prof. E. PINERUA ALVAREZ.

In studying the salts of cobalt, I have succeeded in verifying, without noticing the observations or experiments of Reichel, Winkler, and Donath (1901), that with the hydrates of sodium and potassium in great excess, they give a liquid of a very intense blue colour, especially when heated.

The study of this blue liquid proved to be an alkaline solution of cobaltous anhydroxide of a blue colour (CoO).

By the action of soda in concentrated solution, the pink cobaltous hydrate loses its water, turns blue, and on dissolving it in excess of soda the solution acquires the same blue colour.

The dehydration of the cobaltous hydrate $CoO,H_2O = CoO_2H_2$ is produced not only by soda, but also by caustic baryta, anhydrous calcium chloride, and other substances with an affinity for water, changing it always from pink to blue.

This solution, of beautiful blue colour, is decolorised by the action of water, by hydrolysis of the alkaline cobaltous compound or cobaltite which is formed, $CoO_2K_2$, giving back the original hydrate, $Co(OH)_2$, or other polymeric hydrates with variable formulæ, and colours which oscillate between intense pink and whitish pink, according to the concentration of the alkaline solution and the temperature.

The reaction is so sensitive that it may used in analysis.

It is enough to add a drop of a solution diluted to 1 per cent of cobaltous chloride or sulphate to a great excess of the boiling saturated solution of potash or soda, in order to obtain the *said blue liquid*.

In the presence of a large quantity of nickel salts the precipitate obtained acquires a bluish tint as perceptible as for the small quantity of cobalt.

This blue coloration should not be confounded with that of the compound precipitated by adding in the cold soda or potash to solutions of cobaltous salts. This precipitate, which turns pink on heating, gives *the blue liquid* if a fragment of sodium or potassium hydrate is added, heating afresh until the alkaline solution is sufficiently concentrated.

## THE NITROMETER.

By J. NEWFIELD and J. S. MARX.

Having occasion to use the nitrometer extensively in our work we have made a study of some of the factors which affect the results obtained by means of this instrument, especially with reference to its use in the analysis of nitrocellulose and other explosives. We have used the form known as Lunge's improved nitrometer or gas volumeter.

A description of this apparatus is very well given in Sutton's "Volumetric Analysis," eighth edition, pages 616 to 618. It consists in brief of a decomposing bulb connected by a heavy rubber tube to an overflow. By means of a small piece of rubber tubing this bulb can be connected to a long measuring tube graduated to tenths of cubic centimetres. Temperature and barometric corrections are dispensed with by having a closed tube inserted between the measuring tube and its overflow, all three being joined together by means of a rubber tube. In this sealed tube are 100 c.c. of air over mercury at 760 m.m. pressure and 0° C. temperature. Thus when the volume of air in the tube is 100 c.c. and the mercury column levelled with that in the measuring tube, its gas is also under the same conditions of temperature and pressure,

* Note presented at the Sixth International Congress of Applied Chemistry, held at Rome, 1906.

However, it would be difficult and also unnecessary to obtain just 100 c.c. of air in the sealed tube under standard conditions, so a factor is obtained in the following way:—Approximately 100 c.c. of air are introduced into the sealed tube, then a weighed portion of perfectly pure, dry potassium nitrate is run through the apparatus. From its composition 1 grm. of the nitrate gives 221 c.c. of nitric oxide gas, under normal conditions. The difference between 221 c.c. and what is actually obtained by experiment "fixes" the factor which is used in all subsequent determinations. About 40 to 50 c.c. of sulphuric acid are used in making a determination.

*Effect of Sulphuric Acid of different Concentrations.*

| Strength of acid (per cent). | Cubic centimetres of NO per grm. $KNO_3$. |
|---|---|
| 97·18 | 221·11 |
| 96·59 | 221·08 |
| 94·81 | 221·09 |
| 94·05 | 221·10 |
| 93·02 | 221·60 |
| 90·96 | 223·43 |
| 85·20 | 223·61 |

As the original factor is fixed by the use of potassium nitrate, these results only indicate that changes in the concentration of the acid between 97 and 94 per cent are without effect, but a weaker acid gives too high results, probably because it absorbs less of the nitric oxide. That the stronger acid absorbs nitric oxide was shown by the following experiments:—On agitating 112 c.c. of nitric oxide with 40 c.c. of sulphuric acid of 97 per cent for three minutes, 1 c.c. or 0·89 per cent was absorbed. On shaking 112 c.c, with 40 c.c. of an acid of 85 per cent, 0·5 c.c. or 0·45 per cent was absorbed.

Determinations made with acid from 85 to 50 per cent gave widely varying results, indicating that reliable values can not be obtained with such weak acids.

In the analysis of nitrocellulose and similar explosives the strength of the acid is even more important, as will be seen from the following table:—

| Strength of acid (per cent). | Cubic centimetres of nitric oxide per grm. cellulose. |
|---|---|
| 97·18 | 199·5 |
| 96·59 | 199·5 |
| 94·81 | 199·7 |
| 94·05 | 197·1 |
| 93·02 | 193·1 |
| 88·60 | 147·5 |

Here it is evident that an acid weaker than 94·8 per cent does not effect a complete decomposition of the nitrocellulose, probably because the weaker acids do not completely dissolve the guncotton.

*Effect of Temperature.*—Between 15° and 40° the temperature at which the decomposition is effected is without appreciable effect on the results obtained either with potassium nitrate or with nitro-cellulose. At 40° or above, loss of nitric acid or oxides of nitrogen occurred on the addition of the sulphuric acid, causing low results.

*Effect of Time of Agitation.*—The following results were obtained with acid of 97 per cent at 15°.

| Time of agitation (minutes). | Cubic centimetres of NO per grm. $KNO_3$. | Cubic centimetres of NO per grm. nitro-cellulose. |
|---|---|---|
| 1 | 221·07 | 200·8 |
| 2 | 220·89 | — |
| 3 | 220·98 | 201·9 |
| 5 | 220·97 | 201·8 |
| 8 | 220·92 | 201·8 |

It seems that a complete decomposition of the potassium nitrate is secured in one minute, while three minutes should be used for nitro-cellulose.

*Effect of Pressure.*—The following results were obtained with acid of 97 per cent at 15° C., the pressure being roughly calculated from the difference in heights of the mercury columns in the decomposing and overflow bulbs.

| Pressure (pounds per square inch). | Cubic centimetres of NO gas per grm. $KNO_3$. |
|---|---|
| 7 | 221·73 |
| 14 (normal) | 221·03 |
| 30 | 219·95 |

It is seen from the above that the pressure at which the gas exists exerts a marked effect on the results obtained. This is explained by the fact that the higher the pressure exerted on the gas, the more nitric oxide is dissolved in the sulphuric acid. Always keeping the gas at a slightly reduced pressure appears to give very satisfactory and accurate results.

*Effect of Standing dissolved in Sulphuric Acid.*—Experiments were carried on with the aim in view of determining if there is any marked difference in results to be noted when organic nitrogenous bodies are allowed to remain for some time in sulphuric acid before decomposing in the nitrometer instead of immediately decomposing as is the method employed here. The results follow. As will be noticed, some of the samples were allowed to stand in ice over night to prevent any possible local heating, but the results do not vary much from those which were simply allowed to stand over night under ordinary conditions.

| | First method. Decomposing immediately. | Second method. Standing for twelve hours before decomposing. | |
|---|---|---|---|
| | | In ice. | Not in ice. |
| | 198·1 | 202·8 | 202 |
| Same guncotton .. | 198·3 | 201·6 | 201·6 |
| | 198·0 | 202·3 | 202·6 |
| | | 203·8 | 203·7 |
| | 201 | | 208·2 |
| | | | 205·3 |
| | 201 | | 204·3 |
| | | | 203 |
| | 202 | | 205 |
| | | | 204 |
| | 200 | | 205 (*a*) |
| | 192·3 | | 196·4 |
| | | | 194·7 |
| | 200 | | 205·3 |

(*a*) In desiccator.

With a view of determining the cause of the above difference, a sample of guncotton weighing 0·6 grm. and analysed in the ordinary way (*i.e.*, first method) read 119·7 c.c. on the nitrometer. The gas was run into strong commercial caustic potash solution and after saturation the loss of gas was found to be only 0·7 c.c.

Then into this caustic potash solution, saturated with nitric oxide, was run the gas obtained from one of the guncottons which had been analysed by the second method, and the result was as follows:—

| | |
|---|---|
| First method.. .. .. .. .. | 200 |
| Second method .. .. .. .. | 205·3 |
| After absorption .. .. .. .. | 196·9 |

Several checks were made on the above with similar results.

We know that it is impossible for most of the results obtained by the second method to be correct, for extended researches have shown that guncotton having a nitration of 204 c.c. and upwards is not soluble in a mixture of two parts ether and one part alcohol, and yet all these guncottons tested were practically entirely soluble.

*Effect of other Organic Substances*—The following experiments show the effect of the presence of various organic bodies and other substances (many of which occur in dynamites and gelatins) on the determination of nitrogen by the nitrometer.

In every case a weighed portion of potassium nitrate (about 0·55 grm) was taken and from 0·05 to 0·1 grm. of

substance was added. The mixture was allowed to stand over night in sulphuric acid and was then run through the nitrometer. Of course, in this case standing over night does not affect the result, as there is no organic matter present which can be decomposed, and the small amount of nitric oxide gas lost is constant in all determinations, including those in which the factors were determined.

Results are tabulated as follows :—

| No. | Substance. | Amount taken. Grm. | Result in c.c. | Result with chromic acid. | Result after absorption with KOH. |
|---|---|---|---|---|---|
| 1. | Resin | 0·1 | 212·4 | | |
| 2. | " | 0·1 | | 219·1 | 214·9 |
| 3. | Camphor | 0·1 | 203·4 | | |
| 4. | " | 0·1 | | 219·4 | 199·8 |
| 5. | Sulphur | 0·1 | 225·3 | | |
| 6. | " | 0·15 | 227·3 | | |
| 7. | Paraffin | 0·1 | 199·5 | | |
| 8. | " | 0·05 | 209·5 | | |
| 9, | Vaseline | 0·2 | 217·6 | | |
| 10. | " | 0·05 | 218·7 | | |
| 11. | $MgCO_3$ | 0·05 | 223·4 | | |
| 12. | | | 221·0 | | |

The following can be deduced from the results. All the organic compounds, as in 1, 3, 7, and 9, affect the results in such a way as to give low values. Paraffin has the greatest effect, then camphor, then resin, then vaseline. The effect of adding chromic acid, as seen by the absorption results of potassium hydroxide, is to oxidise some of the carbon to carbon dioxide and thus raise the results, but practically no more nitric oxide is obtained by this treatment. In the table, 2 and 4 show this.

The two inorganic substances used, sulphur and magnesium carbonate, on the contrary, tend to make the result a little high. This is explained in the first case by the formation of a little sulphur dioxide and in the second case by the formation of a little carbon dioxide, which is retained by the sulphuric acid and expelled during the violent shaking in the decomposing bulb. This latter is similar to the cases already cited where carbon dioxide is formed when organic nitrogenous compounds are allowed to remain over night in the sulphuric acid before decomposing in the nitrometer.

In summing up the above results we can at once see that the nitrometer is a very delicate instrument, by which, when all standard conditions are adhered to, very accurate results may be quickly obtained.

The scope of its usefulness, however, is somewhat limited, and a great number of details, apparently trivial, affect the results to a considerable extent.—*Journal of the American Chemical Society*, xxviii., No. 7.

## THE DETERMINATION OF SILICA IN IRON ORES CONTAINING ALUMINA.

By GRAHAM DEAN.

I HAVE found that if the insoluble residue left on the treatment of an iron ore with acids is ignited for a short time the aluminium which it contains is converted into a form which dissolves in concentrated hydrochloric acid. On the basis of this fact the following rapid method for the determination of silica in such ores has been developed.

One grm. of the finely powdered ore is dissolved on the hot plate in concentrated hydrochloric acid, using an initial amount of 25 c.c. Boil until the iron is completely dissolved, adding two or three drops of nitric acid near the end. If pyrites is present, more nitric acid may be required. Nearly all iron ores will yield to this treatment; if an ore does not, the results are worthless.

Evaporate the solution to dryness, take up the residue with a small amount of concentrated hydrochloric acid, boiling till the ferric chloride is all dissolved. Dilute slightly, filter and wash thoroughly with hot hydrochloric acid (1 : 1). If a determination of alumina is required, this filtrate must be examined as well as the solution obtained below.

Transfer the moist filter and residue to a platinum crucible and burn the filter carefully, as usual. Then set the crucible upright, put on the cover, and ignite for two or three minutes over a Dangler burner. I have found that the proper temperature is best secured in a dull or carbon covered platinum crucible. The ignition must not be continued too long and the temperature must be properly regulated.* I have repeatedly attempted to obtain good figures by use of bright and shining platinum crucibles, but have never been able to do so.

When cold the contents of the crucible are transferred to a beaker, the cake pulverised with a glass rod and digested for seven or eight minutes with boiling concentrated hydrochloric acid.† The residue should feel soft and mushy under pressure unless the silica of the ore existed as free sand. Dilute slightly, filter and wash thoroughly. The filtrate may be combined with the first filtrate for the determination of aluminium. The residue, after ignition, may be considered as practically pure silica.

The precipitation of the alumina by phenylhydrazine I have found most satisfactory. (Campbell and Hesse, *Journ. Am. Chem. Soc.*, xxi., 776; E. T. Allen, *Ibid.*, xxv., 423).

The figures given below are an average set selected from a large number of experimental determinations made with Mesabi ores containing in some instances a high percentage of alumina, a large portion of which was proved to be retained in the residue previous to separation and extraction. The results under the heading "Ignition" were obtained by the method given above.

| | Ignition. | Sodium carbonate fusion. | Hydrofluoric acid. |
|---|---|---|---|
| 1 .. .. | 12·86 | 12·83 | 12·94 |
| 2 .. .. | 22·96 | 22·82 | 22·99 |
| 3 .. .. | 17·50 | 17·40 | 17·56 |
| 4 .. .. | 5·16 | 5·00 | 5·10 |
| 5 .. .. | 6·05 | 6·00 | 5·99 |
| 6 .. .. | 13·89 | 13·80 | 13·70 |
| 7 .. .. | 9·84 | 9·92 | 10·06 |

The following amounts of alumina were found in residues obtained by the new method: 0·06, 0·04, 0·10, 0·11, 0·02, 0·07, 0·05, 0·09, and 0·10 per cent. Before the separation by ignition and treatment with hydrochloric acid the residues retained from 4·25 to 10 per cent of alumina. It is evident that the separation is sufficiently complete for technical purposes.—*Journal of the American Chemical Society*, xxviii., No. 7.

## SOME EXPERIMENTS ON THE DETERMINATION OF VOLATILE COMBUSTIBLE MATTER IN COALS AND LIGNITES.‡

By E. E. SOMMERMEIER.

THE method in general use in this country for the determination of volatile combustible matter is that recommended by the Committee on Coal Analysis appointed by

* Dr. Hillebrand explains the results obtained by Mr. Dean by calling in attention to the fact that the aluminium of kaolin is rendered soluble hydrochloric acid by gentle ignition. (See McNeil, *Journ. Am Chem. Soc.*, xxviii., 592). If the ignition is too intense, the aluminium becomes insoluble again. If this explanation is correct, the method would not be reliable for ores containing other silicates than kaolin.—EDITOR *Journ. Am. Chem Soc*

† One-fourth grm. of potassium chlorate added at this stage will give slightly higher alumina results, which are also more concordant with fusion alumina. No time is lost, since the seven or eight minutes allotted will suffice to remove chlorine from the solution as well as alumina from residue.

‡ Published by permission of the Director of the United States Geological Survey. Read before the Columbus Section of the American Chemical Society, May 23, 1906. From the *Journal of the American Chemical Society*, xxviii., No. 8.

the American Chemical Society (*Journ. Am. Chem. Soc.*, xxi., 1122—1126). The directions given are as follows:—

"Place 1 grm. of fresh, undried, powdered coal in a platinum crucible, weighing 20 or 30 grms. and having a tightly fitting cover. Heat over the full flame of a Bunsen burner for seven minutes. The crucible should be supported on a platinum triangle with the bottom 6 to 8 c.m. above the top of the burner. The flame should be fully 20 c.m. high when burning free, and the determination should be made in a place free from draughts. The upper surface of the cover should burn clear, but the under surface should remain covered with carbon. To find 'volatile combustible matter' subtract the per cent of moisture from the loss found here."

This is the method used in the volatile determinations made in the Chemical Laboratory of the United States Geological Survey Fuel Testing Plant, the only modification being that the flame is protected from air currents by enclosing in a cylindrical asbestos shield 15 c.m. long and 7 c.m. in diameter, the platinum triangle being located 3 c.m. below the top of the shield. The use of the shield gives more uniformity in the heat treatment with a corresponding greater uniformity of results. It is well recognised that variations in the size of the crucible, tightness of the lid, strength of the flame, &c., affect the process noticeably. Under uniform conditions the same operator usually has no great trouble with duplicates, but it is quite probable that different operators working even under only slightly different conditions would have considerable trouble in duplicating results.

In most coals the routine results obtained in the laboratory have checked to within less than 0·3 or 0·4 per cent; occasionally a sample has given trouble, and the variation between duplicates without any apparent reason was as great as 1 per cent. On some lignites it has been found impossible to obtain close duplicates, and on a few samples the carrying out of the official method gives very inaccurate results. This may be shown by the results obtained in the laboratory upon two different samples of the same lignite, which samples differed from one another only in the amount of moisture remaining in the air-dried sample, and perhaps in the fineness of the grinding. The results on Sample No. 1 are as follows:—

| | |
|---|---|
| Moisture | 9·88 |
| Volatile matter | 36·17 |
| Fixed carbon | 43·65 |
| Ash | 10·30 |
| Sulphur | 1·30 |

Sample No. 2.

| | |
|---|---|
| Moisture | 20·24 |
| Volatile matter | 58·48 |
| Fixed carbon | 10·85 |
| Ash | 10·43 |
| Sulphur | 1·03 |

This great difference in the fixed carbon results could not be accidental, as all of the results on both samples were duplicated. A series of determinations was begun to determine, if possible, the cause of this great variation. Two causes were suspected, and both were found to be partly responsible for the difference:—1. Mechanical loss due to the throwing out of solid particles by the too rapid expulsion of the volatile matter. The possibility of loss from this source is mentioned in the report of the Committee, but the results of their experiments are negative. 2. A different breaking down of the hydrocarbon compounds when expelled under different conditions and in the presence of variable amounts of moisture.

The results of Mr. N. M. Austin as published in the Committee's report showed that a preliminary treatment of the sample at a low heat and then the application of the full flame of the Bunsen burner gives higher results in fixed carbon than where the full flame of the Bunsen burner is applied from the beginning.

The proximate analysis of the sample of lignite giving the unusual results was finally reported by the laboratory as follows:—

| | |
|---|---|
| Moisture | 20·24 |
| Volatile matter | 35·42 |
| Fixed carbon | 33·91 |
| Ash | 10·43 |
| Sulphur | 1·03 |

A series of seven results by the official method gave for volatile matter on this sample an average of 62·5 per cent with a variation between high and low results of over 12 per cent. Three results of volatile matter on this sample made after previous expulsion of the moisture at 105° gave average volatile matter 39·6 per cent with a variation between high and low results of 5·9 per cent. Preliminary treatment by driving off the moisture and most of the volatile matter at a low heat was then tried, the flame of the Bunsen burner being turned down to 10 c.m., and the crucible gradually heated. The application of the heat was regulated by holding the burner in the hand, and heating in such a way as to expel the moisture slowly, and gradually smoke off most of the volatile matter, the volatile matter escaping freely enough during the last minute of this preliminary heating to burn with a small flame around the edge of the crucible cover. Two results with five minutes of preliminary heating and then seven minutes over the full flame of the Bunsen burner gave an average in volatile matter of 35·08 per cent, the variation between the two results being 0·23 per cent. Two results with three minutes' preliminary heating and seven minutes over the full flame of the Bunsen burner gave an average of 35·6 per cent with a variation of 0·75 per cent between results. A result obtained by four minutes of preliminary heating and then seven minutes over the full flame gave 35·42 per cent. The difference in the results obtained by the three, four, and five minute preliminary treatment is small, and in all subsequent experimental tests the time of the preliminary heating was four minutes. To determine the mechanical losses and difference in volatile compounds given off, a number of ash determinations were made after the driving off of the volatile matter by the official method, and after driving off the volatile matter in connection with the preliminary heating. The results of volatile matter and ash on three determinations by the official method are as follows:—

| | | | |
|---|---|---|---|
| Volatile matter | 66·72 | 67·47 | 54·82 |
| Ash | 4·30 | 4·38 | 7·25 (*a*) |

(*a*) This result is possibly explained by the fact that this sample stood for two hours in the crucible after weighing out, and a considerable amount of the moisture content may have escaped before the sample was treated for the determination of the volatile matter.

Two determinations with four minutes of preliminary heating and then seven minutes over the full flame gave:—

| | | |
|---|---|---|
| Volatile matter | 36·06 | 36·65 |
| Ash | 11·16 | 11·15 |

That mechanical losses occurred during the rapid evolution of the volatile matter by the official method was also indicated by the shower of solid carbon particles driven off as sparks during the first few minutes, while with the preliminary heating these sparks were nearly or entirely absent. The average volatile matter on the first two determinations was 67·1 per cent, the average ash 4·34 per cent. The average volatile matter on the two results by the modified method was 36·35 per cent, ash 11·15 per cent. The moisture in the sample determined at this time was 19·78, giving fixed carbon 32·72 per cent. The difference in the ash results on the two pairs is 6·81 per cent, or the amount of sample driven off mechanically by the regular method is 6·81 ÷ 11·15, or 61 per cent. Taking this portion of the fixed carbon result by the modified method gives 20 per cent as the amount of fixed carbon expelled mechanically in the first determinations.

The results on the official process after making this correction and also taking the correct ash value are as follows :—

| | |
|---|---|
| Moisture .. .. .. .. | 19·78 |
| Volatile matter .. .. .. | 47·10 |
| Fixed carbon .. .. .. | 21·97 |
| Ash .. .. .. .. .. | 11·15 |
| | 100·00 |

After making this correction for mechanical losses the difference in the fixed carbon by the two processes is still 10·75 per cent, which difference must be due to the difference in the breaking down of the hydrocarbon compounds by the different heat treatment. The ash from the third result by the official method was 7·25 per cent, or the loss of ash 3·9 per cent. Correction for fixed carbon mechanically carried off is accordingly 3·9/11·15 or 11·4 per cent. The result, after making the fixed carbon and ash corrections, figures as follows :—

| | |
|---|---|
| Moisture .. .. .. .. | 19·78 |
| Volatile matter .. .. .. | 43·42 |
| Fixed carbon .. .. .. | 25·65 |
| Ash .. .. .. .. .. | 11·15 |
| | 100·00 |

The difference in this case in fixed carbon by the two methods due to the different heat treatment is 7·07 per cent.

*Effect of Fineness of Sample.*—This particular sample was very finely ground. To find out how much this difference in result was due to the fineness of grinding, a duplicate portion of the same sample was ground down till it passed a 40-mesh sieve. The results of duplicates by the official method and the modified method obtained are as follows :—

| | Official method. | Preliminary heating. |
|---|---|---|
| Volatile matter .. | 42·07 | 35·72 |
| Ash .. .. .. .. | 10·25 | 11·20 |

Or loss in ash 0·95 per cent. The proximate analysis of the sample by the modified method is as follows :—

| | |
|---|---|
| Moisture .. .. .. .. | 19·35 |
| Volatile matter .. .. .. | 35·72 |
| Fixed carbon .. .. .. | 33·73 |
| Ash .. .. .. .. .. | 11·20 |
| | 100·000 |

The correction for fixed carbon to be applied to the result of the official method is 0·95/11·20 or 8·5 per cent of the fixed carbon result of the modified method, which is 2·9 per cent. The results by the official method after correcting for mechanical loss of fixed carbon and ash are as follows :—

| | |
|---|---|
| Moisture .. .. .. .. | 19·35 |
| Volatile matter .. .. .. | 39·17 |
| Fixed carbon .. .. .. | 30·28 |
| Ash .. .. .. .. .. | 11·20 |
| | 100·00 |

The difference in fixed carbon between the two methods due to different heat treatment is 3·45 per cent. These results show, at least for lignites, that the fineness of the sample has an important effect upon the result. Upon another sample of lignite similar to the one already tested, except that it contained more moisture (30·45 per cent), the results obtained are as follows :—

Average of results by the modified process—

| | |
|---|---|
| Moisture .. .. .. .. | 30·45 |
| Volatile matter .. .. .. | 30·97 |
| Fixed carbon .. .. .. | 27·75 |
| Ash .. .. .. .. .. | 10·83 |
| | 100·00 |

The results in volatile matter and ash by the official method—

| | |
|---|---|
| Volatile matter .. .. .. | 44·40 |
| Ash .. .. .. .. .. | 8·12 |

Hence, the correction to be applied to the fixed carbon and ash for mechanical loss is 2·71/10·83. Applying these corrections, the results by the official method are—

| | |
|---|---|
| Moisture .. .. .. .. | 30·45 |
| Volatile matter .. .. .. | 37·43 |
| Fixed carbon .. .. .. | 21·29 |
| Ash .. .. .. .. .. | 10·83 |
| | 100·00 |

The difference in the fixed carbon results between the two samples due to different heat treatment is 6·46 per cent.

To test the effect of the fineness of grinding upon the determination of the volatile matter in ordinary bituminous coal, a sample of Kentucky coal containing 2 per cent moisture, 5·7 per cent ash, and 0·9 per cent sulphur was still further reduced in ash content by floating on a calcium chloride solution, sp. gr. 1·32. The lighter portion was then thoroughly air-dried and separated by sifting into the following sizes :—One-fourth to one-tenth, one-tenth to one-twentieth, one-twentieth to one-fortieth, one-fortieth to one-eightieth, and one-eightieth and finer. The proximate analyses of the samples by the official method are as follows :—

| | Moisture. | Volatile matter. | Fixed carbon. | Ash. |
|---|---|---|---|---|
| 1/4 to 1/10.. .. | 1·15 | 39·05 | 58·20 | 1·60 |
| 1/10 to 1/20 .. | 1·45 | 38·80 | 58·55 | 1·20 |
| 1/20 to 1/40 .. | 1·70 | 38·55 | 58·35 | 1·40 |
| 1/40 to 1/80 .. | 1·90 | 38·05 | 58·40 | 1·65 |
| 1/80 and finer .. | 2·05 | 35·54 | 59·66 | 2·75 |

By the modified process with four minutes of preliminary heating the result in volatile matter on the one-twentieth to one-fortieth size was 33·75 per cent and on the one-eightieth and finer 32·85 per cent.

The results in volatile matter on these different sizes are somewhat higher on the coarse samples. However, the different ash contents of the different sizes indicate that the sizing had to a degree separated the coal into somewhat different varieties, as the higher ash content of the finer sample would not in itself be sufficient to account for the lower volatile results. In order to see whether the difference was due to the fineness of grinding or difference in the coals, a portion of the one-twentieth to one-fortieth sample was ground down in an agate mortar and the volatile matter determined on this fine portion. The average of several results was 37·6 per cent as against 38·55 per cent on the coarse sample.

From this series of results it appears, at least in low moisture bituminous coals, that the finer ground samples give somewhat lower volatile matter than the coarser samples, probably due to the more complete sintering together of the fine samples upon heating, with the consequent effect upon the giving off of the volatile matter.

*Effect of Different Heat Treatment.*—In order to find out how much effect different heat treatment has on different coals, a series of samples was selected ranging from anthracite to peat, most of the samples used in the tests having been previously more or less completely air-dried so as to permit of better handling in the laboratory. Determinations for volatile matter were made in duplicate by the regular official method and by the four-minute preliminary heating method. The proximate analysis of the samples with the volatile matter determined by the official method is tabulated in the first five columns; the results for volatile matter by the preliminary heating are given in the sixth column; the differences in volatile matter by the two methods are given in the seventh column. The determinations for moisture were all made in accordance with the official method by weighing out a separate sample.

The same is true of the determinations for ash with the exception that upon two or three of the lignite samples and one of the Pennsylvania samples the results for ash are those obtained after the determination of the volatile matter by the modified process. These particular samples and results are all specifically mentioned elsewhere in this paper.

| Source of coal. | Moisture. | Official method. Volatile matter. | Fixed carbon. | Ash. | Sulphur. | Volatile matter with four mins. preliminary heating. | Difference. |
|---|---|---|---|---|---|---|---|
| Colorado anthracite .. | 2·80 | 5·05 | 77·55 | 14·60 | 0·60 | 4·90 | 0·15 |
| Arkansas .. | 0·83 | 12·47 | 72·05 | 14·65 | 2·14 | 12·37 | 0·10 |
| Pennsylvania. | 0·90 | 17·35 | 74·92 | 6·83 | 0·97 | 16·07 | 1·28 |
| Pennsylvania. | 1·05 | 33·10 | 53·30 | 12·55 | 1·76 | 30·35 | 2·75 |
| Kentucky .. | 2·99 | 37·51 | 56·68 | 2·82 | 0·58 | 34·78 | 2·73 |
| Indiana . .. | 4·20 | 37·70 | 45·65 | 12·45 | 4·13 | 34·67 | 3·03 |
| Washington . | 6·65 | 35·87 | 44·57 | 12·91 | 0·68 | 34·25 | 1·62 |
| Indiana . .. | 8·40 | 34·40 | 48·72 | 8·48 | 1·47 | 32·00 | 2·40 |
| North Dakota (lignite) .. | 11·65 | 45·58 | 32·97 | 9·80 | 1·04 | 40·17 | 5·41 |
| Illinois .. .. | 12·40 | 32·18 | 42·82 | 12·60 | 1·30 | 30·12 | 2·06 |
| Texas lignite (fine) . .. | 19·78 | 62·50 | 6·57 | 11·15 | 1·03 | 35·42*a* | 27·08 |
| Texas lignite (40-mesh duplicate) . | 19·35 | 42·07 | 27·38 | 11·20 | — | 35·72 | 6·35 |
| Texas lignite not air-dried | 30·45 | 44·40 | 15·42 | 9·73 | — | 30·97 | 13·43 |
| Massachusetts peat .. .. | 13·25 | 49·80 | 16·21 | 20·74 | 0·58 | 47·92 | 1·88 |

*a.* Two determinations upon the fine sample of Texas lignite made by heating for four minutes over a flame 5 c.m. high and then seven minutes over the full flame (25 c.m.) gave 35·47 per cent volatile matter. Almost an exact check upon the result obtained by the four-minute preliminary heating with a 10 c.m. flame regulated by holding burner in the hand.

With the exception of the anthracite and semi-anthracite samples, the results by the preliminary heating as compared with the official method all show a considerably less amount of volatile matter and a correspondingly greater amount of fixed carbon. In the case of the lignites, the greater volatile matter by the official method, as has been shown, is partly due to mechanical losses.

In order to see if mechanical losses might account for the differences on the bituminous coals, determinations for the ash after the determination of the volatile matter were made on one of the Pennsylvania samples. The average results for ash on the sample by the two methods are as follows:—

| | Ash. |
|---|---|
| Official method .. .. .. | 12·56 |
| Preliminary heating .. .. | 12·53 |

These results indicate no mechanical loss whatever, and in none of the samples except the lignites were visible solid carbon particles driven off in the form of sparks, and the differences must be ascribed to the different breaking down of the hydrocarbon compounds by the difference in heat treatment.

*Effect of the Presence of Moisture.*—Comparisons of the results of volatile matter on a great number of samples differing from one another in moisture content indicate that the presence of loosely held moisture in the sample causes a higher volatile result. In order to obtain more definite data on this question three samples low in moisture and representing widely different kinds of coal were selected for a series of determinations. The effect of loosely held moisture upon the determinations for volatile matter in each of these samples was determined by adding to the sample after weighing out definite amounts of water, which was thoroughly mixed with the sample by means of a fine platinum-wire, and the volatile determination then made in the usual manner according to the official method. The first sample selected was a sample of Pennsylvania coal. The proximate analysis of the air-dried sample is as follows:—

| | |
|---|---|
| Moisture .. .. .. .. | 1·05 |
| Volatile matter .. .. .. | 33·00 |
| Fixed carbon.. .. .. .. | 53·30 |
| Ash.. .. .. .. .. .. | 12·55 |
| Sulphur .. .. .. .. .. | 1·75 |

The results for volatile matter in this sample determined in the presence of additional moisture are as follows:—

| | Volatile matter. |
|---|---|
| With 0·05 grm. additional moisture.. .. | 33·60 |
| " 0·1 " " .. .. | 33·70 |
| " 0·15 " " .. .. | 33·80 |
| " 0·2 " " .. .. | 34·10 |
| " 0·3 " " .. .. | 33·90 |

The second sample was an air-dried sample of Illinois coal, the proximate analysis of which by the regular official method is as follows:—

| | |
|---|---|
| Moisture .. .. .. .. | 1·35 |
| Volatile matter .. .. .. | 39·35 |
| Fixed carbon.. .. .. .. | 44·65 |
| Ash.. .. .. .. .. .. | 13·65 |

The results of volatile matter with the additional moisture added to the sample are as follows:—

| | Volatile matter. |
|---|---|
| With 0·03 grm. additional moisture.. .. | 39·60 |
| " 0·05 " " .. .. | 39·30 |
| " 0·10 " " .. .. | 40·00 |
| " 0·15 " " .. .. | 40·05 |
| " 0·2 " " .. .. | 39·75 |

The third sample was an air-dried sample of Arkansas lignite, the proximate analysis of which by the official method is as follows:—

| | |
|---|---|
| Moisture .. .. .. .. | 10·85 |
| Volatile matter .. .. .. | 38·50 |
| Fixed carbon.. .. .. .. | 31·40 |
| Ash.. .. .. .. .. .. | 19·25 |
| Sulphur .. .. .. .. .. | 0·83 |

The results for volatile matter with the additional moisture are as follows:—

| | Volatile matter. |
|---|---|
| With 0·05 grm. additional moisture.. .. | 40·35 |
| " 0·10 " " .. .. | 41·20 |
| " 0·15 " " .. .. | 40·90 |
| " 0·20 " " .. .. | 44·90 |

Without exception all of these results show that the presence of loosely held moisture in the sample increases the value obtained for the volatile combustible matter. The average increase for the Pennsylvania sample is about 0·7 per cent. On the Illinois sample the increase for volatile matter is 0·4 per cent. On the Arkansas lignite the increase is 3·3 per cent.

To see what effect this loosely held moisture might have on the volatile determinations where the sample was first subjected to four minutes of preliminary heating over a low flame, determinations were made upon these samples with and without additional moisture. The results are as follows:—

Pennsylvania sample with no moisture added, volatile matter 30·35. With 0·3 grm. added, the volatile matter 31·65.

The Illinois sample with no moisture added, volatile matter 34·85. With 0·15 grm. moisture added, volatile matter 36·10.

The lignite sample with no moisture added, volatile matter 36·90. With 0·2 grm. moisture added, 37·40.

These results show that even with a gradual preliminary heating the presence of loosely held moisture increases the value of the volatile determinations, the difference in some of the samples being as great as the difference by the official method, from which it appears that the rapid application of heat sufficient to drive off this moisture results in a reaction between the water vapour and the carbon or hydrocarbons in the coal.

*Conclusions.*—The results of the foregoing experiments and tests show that the value obtained for volatile matter in coal is affected to an important degree by the method of heating the sample, by the fineness of pulverisation, and by the amount of loosely held moisture present. In bituminous coals these differences do not exceed 3 or 4 per cent, and appear to be entirely due to a different breaking up of the hydrocarbon compounds under the different conditions of heat treatment, fineness of sample, and amount of moisture present. In the case of lignites where the difference may be as high as 25 per cent this difference is largely due to the mechanical loss in the sample during the rapid expulsion of the volatile matter.

*Correctness of Results.*—Since the determination of the volatile matter is a purely arbitrary one unless mechanical loss can be shown, as in the case of lignites, it appears that any results obtained by following out the regulation method should be considered as correct, any difference in results due to differences in fineness of pulverisation or to the amount of moisture present having no effect upon the correctness of the value actually obtained. The differences due to difference in pulverisation or moisture content do, however, have a very important effect when it comes to the question of different chemists obtaining concordant results upon different samples of the same coal.

In regard to the difference in results obtained due to a different heat treatment, while the method of heating as given by the official method may be considered as giving the correct result, it does not necessarily give us a result approximating very closely the volatile matter as given off when the coal is fired under a steam-boiler or especially when coked in a coke oven, as under these conditions the volatile matter is driven off gradually and during a considerable interval of time, and it appears that the slower driving off of the volatile matter from the sample in the laboratory gives results more in accordance with these conditions than does the official method. This latter fact is, however, a matter of minor importance, for so long as all volatile determinations are done in the same way it makes very little difference what that way is.

In the case of lignites where the application of the official method causes mechanical losses it appears desirable and necessary that the Committee so modify the official method for volatile matter in lignites as to prevent this loss, and the results of these foregoing determinations and experiments are published at this time with a view of bringing this matter before the Committee and the public.

## DISCOLORATION OF FRUITS AND VEGETABLES PUT UP IN TIN.

By F. A. NORTON.

A NUMBER of cases of discoloration of fruits and vegetables put up in tin have come to the attention of the writer. In most cases the discoloration was undoubtedly due to sulphides of the heavy metals, the discoloration in some cases being confined to the container, in others affecting the fruits and vegetables as well. The source of the hydrogen sulphide varied in different cases. Some micro-organisms are capable of evolving hydrogen sulphide through breaking down of proteid matter, but this would result only with goods which were not properly sterilised and is not so frequent as some other causes. Also such goods are unfit for consumption, so that the discoloration is of minor importance. In other cases hydrogen sulphide resulted from the use of sulphites in connection with fruits, reaction having taken place between the sulphites and vegetable acids with the liberation of sulphurous acid, which, acting upon the tin of the container, had produced hydrogen sulphide. Another source of hydrogen sulphide was the decomposition of proteid matter through the use of an exceptionally heavy process by the action of steam under pressure on the proteids. Where discoloration had taken place in the goods, the source of the heavy metals was the tin plate and solder of the container.

All fruits and vegetables, as has been shown by Leach ("Food Inspection and Analysis," p. 696), have a greater or less solvent action upon the tin plate and solder of the container, taking up variable amounts of tin and lead, the extremely acid fruits, like rhubarb, being most active, though some of the vegetables, such as squash and pumpkin, take up very large amounts of tin.

Having pointed out the source of the heavy metals and the hydrogen sulphide, one can very readily understand how the discoloration of these goods would take place. A history of some cases in point will best illustrate the different forms of discoloration.

Recently, some badly discolored pears were sent in to the laboratory for examination. On opening the can a heavy brownish black deposit was discovered over the inside of the can, and wherever the pears came in contact with the can there was also the same deposit on the fruit, rendeting it unsightly and unfit for the market. Previous experience by the director of the laboratory. Mr. E. W. Duckwall, at once suggested that sulphites had been used in the preparation of the fruit, and that the discoloration was probably due to their use. Determinations for sulphites were made and they were found to be present in very large quantity. The character of the discoloration, which almost assumed the form of a deposit, suggested to us that it was due to metallic sulphides, principally tin sulphide, resulting from the reaction between the sodium sulphite, vegetable acids, and tin.

In order to ascertain whether this was the case or not, pieces of pear of good colour were placed in two beakers with pieces of tin and solder in each. To one sodium sulphite was then added and the other simply left in water. The pear not treated with sodium sulphite kept its colour perfectly on standing in contact with the tin and solder, but the pear in the beaker to which sulphites had been added soon began to darken, and in the course of two or three days the same brownish-black appearance observed in the discoloration of the pears in the case at hand had permeated nearly the whole pear tissue of the sample under treatment in the beaker. Some of the brownish deposit, also some of the discolored fruit from the can showing the discoloration, was treated with strong hydrochloric acid, which immediately destroyed the discoloration of the pear tissue and brought the deposit into solution. On diluting, filtering, and precipitating with hydrogen sulphide, a small quantity of tin sulphide was obtained, which indicated that the discoloration was due to sulphide of tin and other metallic sulphides. This was further confirmed by treating the inside of the discolored can in which the pears had been put up with strong hydrochloric acid, and testing the fumes given off with lead acetate paper for hydrogen sulphide. A very positive reaction was obtained for sulphides, which was confirmed by other tests. In fact, the odour of hydrogen sulphide evolved from the decomposition of the sulphides seemed to be unmistakably present. This experimental data seemed to show conclusively to us that the discoloration was due to metallic sulphides resulting from the hydrogen sulphide which had been liberated by reaction between the sulphites and the tin, aided by the fruit acids present.

To further test this view pieces of tin-foil were treated with sodium sulphite and also with sulphurous acid solution. The tin-foil in the sulphurous acid solution quickly became discolored with a considerable brown deposit,

which was shown to be tin sulphide, while that in the sulphite solution remained perfectly bright. This would indicate that there would not be much danger of discoloration from reaction between sulphites and tin in a neutral medium, but that where sulphurous acid would be liberated discoloration would be very sure to result.

Other pieces of tin-foil were then treated in beakers with sodium sulphite solution to which various acids, such as acetic, lactic, tartaric, citric, and others, had been added. In each case discoloration resulted, showing that the vegetable acids had liberated sulphurous acid, which in turn reacted with the tin to form tin sulphide, giving the discoloration. Most fruits contain appreciable amounts of such acids as citric and malic acid. In some cases, where fermentation has taken place to any extent, acetic or lactic acid is present, and fruits or vegetables containing any of these organic acids, if treated with sulphites, are very sure to produce discoloration.

Soldering fluxes sometimes are somewhat acid, and if a little excess is used, permitting the acid to come in contact with the goods, if these are treated with sulphites, discoloration is very sure to be observed at points where the acid has come in contact with the fruit or vegetable. While it would seem that sulphites can be used without any danger of discoloration in neutral substances, there certainly is much danger of discoloration if they are used in products of a somewhat acid character put up in metal containers.

Discoloration from hydrogen sulphide evolved through the employment of a heavy process is illustrated by the following case:—In order to secure the proper cooking of the large siftings of peas, which was not readily accomplished in the blancher, the packer had lengthened the process to fifty-five minutes at 240°, with the result that this pack of peas contained a very large percentage of cans containing discolored peas, while the smaller siftings of peas given a shorter process were free from the discoloration. An examination of the peas in the containers showed the cans to be very much discolored, the inside of the can being of a brownish purple colour, though there was nothing in the shape of a deposit. The discoloration of the peas was confined more particularly to those around the outer portion of the can, and the discoloration did not extend into the peas to any great extent. Some of the more badly discolored peas were separated out and a determination of tin made, which was found to be present in considerable quantity. Also the discoloration, both of the peas and the can, was soluble in strong hydrochloric acid, which would be the case with tin sulphide. Reactions for hydrogen sulphide were obtained from the inside of the can quite readily, both with lead acetate paper and sodium nitroprussiate. This same discoloration of the can is noticeable wherever a heavy process is employed and had previously been found by the writer to react for sulphides, evidently being due to tin sulphide formed through hydrogen sulphide liberated during the processing. There is seldom discoloration of the contents, but in this case it seemed that sufficient hydrogen sulphide had been liberated, together with the tin and lead taken up by the contents of the can, to produce the discoloration. Experiments which have been made show that when proteid substances are acted upon by steam under pressure ammonia and hydrogen sulphide are split off from the proteid molecule, with the formation of albumose and peptone. Dr. Long, in his recent work, in his discussion of proteid substances ("Physiological Chemistry," p. 74), gives special attention to the decomposition of proteid substances, by steam under pressure, stating that if the temperature is high enough the reaction will extend even beyond the formation of ammonia and hydrogen sulphide, resulting in the complete destruction of the proteid molecule. This would explain the source of the hydrogen sulphide, and, taking into consideration the fact that tin and some lead would have been taken up by the peas, would explain the discolora tion of the goods.

In order to assure ourselves that sufficient hydrogen sulphide would be produced under a very heavy process to cause the discoloration, two glass jars were filled with peas and to one 50 m.grms. of stannous chloride were added. and both were processed at 240° for an hour. The peas in the jar to which the tin chloride had been added showed a very marked brown discoloration, from which the other peas were entirely free, which would confirm our findings in this case.

In some cases, especially in corn, we have encountered a discoloration which was more local in character than in the case of the peas just described. In this case the discoloration was confined almost entirely to the vicinity of the seams and cap. As corn is a very stable product and does not change its position in the can, it would appear that the discoloration in this caae had come more particularly from the solder or from an excess of flux. It has been shown that where a poor grade of solder containing a large amount of lead is used, the action of the fruit or vegetable juice is greater, more metal being brought into solution. Also if an excess of soldering flux. especially if somewhat acid in character, should remain along the seam, it would result in more of the metal of the container being taken up by the contents of the can at those points, and then on liberation of hydrogen sulphide during the process discoloration would result at those points, while the contents of the can otherwise would be free from discoloration.

From the above, it can be stated that sulphites should not be used with goods of an acid character which are to be put up in tin. Where a heavy process is necessary, care should be exercised to avoid the use of an excess of flux or the use of low-grade solder or tin-plate which would tend to increase the amount of heavy metals taken up by the goods. Also the length of the process, in order to avoid evolution of hydrogen sulphide, should be as short as possible, consistent with complete sterilisation of the goods. —*Journal of the American Chemical Society*, xxviii., No. 10.

# PROCEEDINGS OF SOCIETIES.

## FARADAY SOCIETY.

*Ordinary Meeting, December 11th*, 1906.

Dr. T. M. LOWRY in the Chair.

DR. A. C. C. CUMMING read a paper entitled "*Contributions to the Study of Strong Electrolytes.*"

I. *The Elimination of Potential due to Liquid Contact.*—Certain solutions have the property of reducing the potential due to the contact of two solutions, and potassium chloride has been used for this purpose. In most cases a saturated solution of potassium chloride does not remove all the diffusion potential; indeed, if the solutions in the cells be strong, it only removes a small part. This property of removing more or less of the diffusion potential depends on two factors in the connecting solution: firstly, the positive and negative ions must be of equal velocity; and, secondly, the concentration of the connecting solution must be high compared with the solutions in the cells.

The author suggests a saturated ammonium nitrate solution as that which fulfils these two conditions better than anything else at present known, and shows by experiments with different cells that this is the case.

A curious point was noticed when two cells containing the same solution, but of different concentrations, were joined by a third solution of the same substance. Whatever the strength of this third solution, the observed potential remained the same as when the two cells were directly connected with one another. This has not been recorded before, but could have been predicted from Nernst's theory.

II. *The Potentials of Silver Nitrate Solutions.*—The electromotive force between silver nitrate solutions of

various strengths from N/1000 up to N/2 was measured as accurately as possible. Three kinds of silver electrodes were used, and various methods were tried to eliminate the small amount of diffusion potential.

The results proved that for silver nitrate the electromotive force gives the same measure of the ionic concentrations as is obtained from the conductivities, and therefore support the view that the conductivity gives a true measure of the ionic concentration.

Mr. N. T. M. WILSMORE said that the author's method of eliminating liquid contact potential was a distinct advance on Planck's formula which was limited in its application.

A paper on "*The Electrochemistry of Lead*" was then read in abstract by Dr. A. C. C. CUMMING.

The tendency of any ion ($i$) to be transformed into an ion ($o$) with a lower valence may be measured by means of an oxidation electrode. If $n$ be the difference in valence of the two forms, the E.M.F. in volts—

$$= P + \frac{0{\cdot}0591}{n} \log_{10} \frac{C_i}{C_o} \text{ (at 25°)},$$

where the symbols have their usual meanings.

A solution containing plumbic lead was obtained by dissolving $PbO_2$ in nitric acid, and the amount estimated analytieally, while any desired strength of plumbous lead was obtained by addition of ordinary lead nitrate. The potentials were measured with a lead peroxide electrode, against a N calomel electrode, with a saturated ammonium nitrate solution as connection. The mean value for P, *i.e.*, the tendency $Pb^{\cdot\cdot\cdot\cdot} \rightarrow Pb^{\cdot\cdot}$, was found to be $+1{\cdot}82$ volt against the hydrogen standard electrode. The value for $Pb^{\cdot\cdot} \rightarrow Pb$ was also re-determined, and found to be $-0{\cdot}137$ volt, so that the value for $Pb^{\cdot\cdot\cdot\cdot} \rightarrow Pb$ is $+0{\cdot}84$ volt.

Some experiments were carried out to find how the addition of nitric acid affected the ionisation of lead (plumbous) nitrate. The solubility of lead nitrate was shown to decrease very rapidly with increase of the nitric acid concentration.

Measurement of the plumbous ion concentration in alkaline nitrates showed that this varied greatly in different solutions, and the results proved that there was considerable complex formation between $KNO_3$ and $Pb(NO_3)_2$, but not so between $NaNO_3$ and $Pb(NO_3)_3$.

The results in general prove that lead in the tetrad form is a highly electro-positive element, and also direct attention to a curious difference in the behaviour of sodium and potassium nitrates towards lead nitrate.

Mr. N. T. M. WILSMORE remarked on the bearing of the author's experiments on the theory of accumulators as propounded by Dolezalek. A theory based on tetravalent ions would be more satisfactory than that built up by Dolezalek on the theory of $PbO_2$ ions assumed by Liebenow.

A paper by Mr. R. W. VICAREY on "*Storage Batteries and their Electrolytes*" was, in the absence of the author, read in abstract by the Secretary.

The paper is a continuation of one read by the author in July, 1905, and deals chiefly with some of the problems involved in the manufacture of accumulators, particularly as regards the effect of nitrogen and other impurities introduced consciously or by accident in the process of manufacture. Nitrogen compounds are often used, and advisedly so in the opinion of the author, for assisting in the oxidation of the positive plates, and in such cases it is essential that every trace of nitrogen be removed before the cells leave the works, in spite of the difficulties, which are insisted upon, involved in its complete elimination. The evils attributed to nitrogen, both after complete formation and in the latter stages of the forming processes, are described in detail. Among other troubles, the author has observed the formation of an irreducible and unoxidisable sulphate of lead, $2PbSO_4.PbO$, a detailed study of the effects of which are promised for a future communication. The evil effects of nitrogen are greatly accentuated by the presence of other impurities—notably iron, an element likewise very difficult to eliminate—and experiments are described illustrating these effects, which become more serious with decreasing current densities. Researches of Peters, Elbs, and Bell are quoted in support of the author's main contentions.

Mr. H. L. JOLY criticised in detail many of the author's contentions. He could not accept the extreme "ammonia" theory claimed by the author, who had not furnished sufficient definite and reliable data to found hypotheses upon. He would like to have had an account of the physical contents of the "new" lead sulphate. After hearing Dr. Cumming's paper, he was surprised that the author had used platinum, and not the more reliable lead electrodes in his experiments on the effect of impurities. The accentuation of separate effects of ammonia and iron by combining them together was of great interest, but the experiments needed elaborating.

# CORRESPONDENCE.

## MELTING-POINT OF CARBON.

*To the Editor of the Chemical News.*

SIR,—The following little calculation *re* the melting-point of carbon occurred to me, but it is so obvious, and also so indefinite, that I hesitate to send it to you.

From Van der Waals' equation we learn to compare substances relatively to their critical constants. According to Weber, the atomic heat of graphite seems to tend to a limiting value at high temperatures. Taking his last few numbers, somewhere about 2000° seems to be the point at which the mean 6·4 would obtain. Now oxygen solidifies at 50° absolute, and its critical temperature is 155·8° on the same scale; therefore the temperature at which solid oxygen would give the mean value for its atomic heat must have limits of 0—50° absolute. If we take the mean 25°, and apply the ratio of its critical temperature to this temperature to the case of carbon, we get approximately—

$$\frac{155}{25} \times (2000^{\circ} + 273^{\circ}), \text{ or about } 14{,}000^{\circ} \text{ Abs.},$$

as the critical temperature of carbon.

Applying now the oxygen relationship again to this result we get $\frac{50}{155} \times 14{,}000°$ Abs., or somewhere about 4000° C., as the melting-point of carbon, which is interesting from the fact that Crookes places it, I believe, at about 4100° C.—I am, &c.,

R. H. MCCRAE.

New College, Herne Bay,
December 8, 1906.

## THE ORIGIN OF JET.

*To the Editor of the Chemical News.*

SIR,—As the translator into English of Neuburger and Noalhat's "Technology of Petroleum," in which the different theories as to the origin of petroleum are discussed at some length, and as a teacher of geology and mineralogy, I am interested in Mr. Spielmann's article on the origin of jet, which also incidentally touches on the origin of petroleum (CHEMICAL NEWS, xciv., p. 281). The question seems a difficult one, as the evidence which points one way seems to be refuted by equally strong evidence in an opposite direction. I am rather surprised that Mr. Spielmann should ignore the electrical properties of jet as affording a clue to its origin. "Jet," says Bishop Watson, "however, when warmed by friction has the power of attracting bits of straw, feathers, and other light bodies, but I have never observed this property in any of the cannel coals which I have tried" ("Chemical Essays," 1782, vol. iii., p. 11).

This electrical property and its association with the fossil remains of conifers points to jet having a common origin with amber. This theory of mine is further confirmed by Bishop Watson's account of the geological occurrence of amber and his theory of its formation, which in some points seems to tally with Mr. Spielmann's theory of the origin of jet. "The superincumbent strata are sand, fossil wood, pyrites; sand, again, in which the amber is found—sometimes in detached pieces, sometimes in little heaps. This distribution of the strata where amber is found, together with their proximity to the sea, has led it to be inferred with some probability that this mineral owed its situation to the inundation and reversion of the sea, and that it was derived parrly from an oil arising from the decomposition of vegetables by subterranean fire, and partly from a mineral acid. Amber is frequently found in Italy, where they have no fossil wood but get plenty of petroleum" (*loc. cit.*, pp. 13, 14).

Is jet metamorphosed amber or resin? As to the intermediate jet products referred to by Mr. Spielmann, I should say the electrical capacity of the jet would be a better guide than the polish. Then there are the destructive distillation products to be considered. I do not recollect having seen a full statement of the latter.

Again, ground paraffin shale is a useful pigment (mineral black), but if massive jet be a brilliant black, powdered it is a dirty grey. Why? May I be allowed to protest against the introduction of radio-activity to explain the origin of jet. where it seems as unnecessary as it would be if introduced to explain the origin of rosin-pitch or bone-pitch (pitches which rival natural asphaltum in lustre, but very intractable as regards solvents). Volcanic gases would separate impure carbon from crude bone-tar. The fact may be of theoretical importance. "Radio-activity" seems to me through abuse of the term to be destined to exert as retarding and pernicious an influence on the progress of chemistry as the phlogiston of old.

On more than one occasion I have started this distillation and collected the petroleum-like fractions apart, but had eventually to discard tnem for lack of opportunity to work them up. I used up to equal weights of rosin and sulphur, and got in each case several different coloured distillates of different viscosities. Needless to say, a strong mercaptan-like odour was given off during the distillation, but I made no attempt to collect the gas.

Will some one else with better opportunities take up the subject? I am sure it would pay well for thorough threshing of it out.

Were it not that the difficulty would have to be encountered as to how petroleum is met with so far down in the geological scale, I would suggest that petroleum is a caoutchouc or gutta derivative. It only requires the shifting of the earth's axis to make our present caoutchouciferous and guttiferous zones coincide with the petroleum lines of strike of the present day. Rubber is the only vegetable product which yields gasolene on destructive distillation.

Trusting you will find room for these remarks on an interesting subject, they only seem the natural development of certain points in Mr. Spielmann's article, which is, in fact, a plea for the resiniferous origin of petroleum and jet. Interesting results as to origin of petroleum might be got from a chemical point of view by distilling rosin with sulphur.—I am, &c.,

JOHN GEDDES MCINTOSH.

9, Parsonage Street, Cubitt Town, E.

P.S.—On re-studying the article, the following sentence on p. 282 still further accentuates the force of my contention that jet is a resin derivative akin to the hard pitch from a rosin still:—"And in some specimens where partial fossilisation has occurred jet has formed that part of the wood unpreserved by the substituting materials." These are very evidently resiniferous vessels, resin pockets, &c., which for several and very evident reasons resisted the seudomorphous transformation.—J. G. M.

## HELIUM OR HELION?

*To the Editor of the Chemical News.*

SIR,—Is the termination *um* still regarded as characteristic of metallic elements and *ion* of non-metallic elements? If so, why is it not decided to write hel*ion* instead of hel*ium*; or is it that the metallic nature of the element has been placed beyond all doubt?—I am, &c.,

S. ARCHD. VASEY.

Bromley, Kent, December 19, 1906.

# CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

*Comptes Rendus Hebdomadaires des Séances de l'Academié des Sciences.* Vol. cxliii., No. 24, December 10, 1906.

**A Colour Reaction of Reducing Sugars given by Alkaline *m*-Dinitrobenzene.** — MM. Chavassier and Morel.—The authors have made numerous applications of the reaction of aldehydic and ketonic sugars upon *m*-dinitrobenzene in a strongly alkaline medium, which by their reducing action give rise to the formation of a violet colouring matter, turning yellow with mineral acids. The following results were obtained:—1. With saccharose, no coloration; with maltose and lactose, violet coloration after some minutes; with dextrose, galactose, and arabinose, violet coloration after some minutes; with levulose, violet coloration in less time; with glycogen, no coloration. The weaker the solutions of the sugars the longer the time taken to produce the violet coloration. 2. Other reducing substances besides the sugars give colorations with the same reagent, *e.g.*, aldehydes and ketones without the alcoholic group give a red coloration, which would mask the violet coloration of the sugars; therefore, in employing *m*-dinitrobenzene for the sugars, it is necessary to be assured of the absence of aldehydes and ketones. Uric acid gives the same coloration as the sugars, and must be eliminated before research upon the sugars can be proceeded with. 3. Albumins, albumoses, acid amides, urea, creatine gave no reaction. Hence the violet coloration given with *m*-dinitrobenzene serves equally with the other usual methods for detecting the presence of the reducing sugars, and it has the advantage of great ease of execution.

**A Tetrabrom-derivative of Methylethylketone.**—M. Pastureau.—The author has obtained a new body, tetrabrome-methylethylketon, $C_4H_4OBr_4$, by the action of bromine upon the superoxide of methylethylketone prepared by the action of acidified hydrogen peroxide upon methylethylketone. Hitherto only monobrom-derivatives and a hexabrom-derivative of methylethylketone, $CH_3—CO—CH_2—CH_3$, have been known. The tetrabrom-derivative consists of white octahedral crystals, insoluble in water, soluble in boiling alcohol, little soluble in cold alcohol. The constitution, determined by saponification with an aqueous solution of potassium carbonate, appears to be $CH_2Br—CO—CH_2—CBr_3$, since an acid $\beta$-ketonic alcohol is produced,—

$$CH_2OH—CO—CH_2—\overset{\cdots\cdots}{\underset{\cdots\cdots}{:COO:}}H,$$

which readily decomposes, and gives acetol by losing $CO_2$.

## MEETINGS FOR THE WEEK.

| | |
|---|---|
| TUESDAY, Jan. 1st.<br>THURSDAY, „ 3rd.<br>SATURDAY „ 5th. | Royal Institution, 3. (Christmas Lectures, adapted to a Juvenile Auditory). "Signalling to a Distance, from Primitive Man to Radio-telegraphy" (Experimentally Illustrated), by W. Duddell, M.Inst E.E. |

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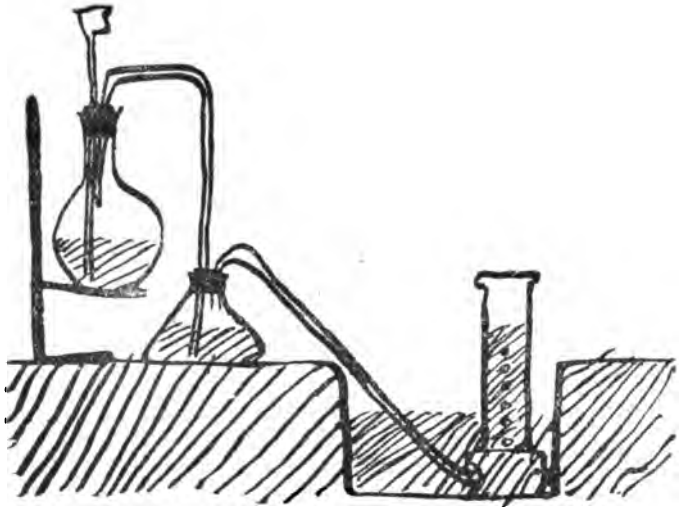

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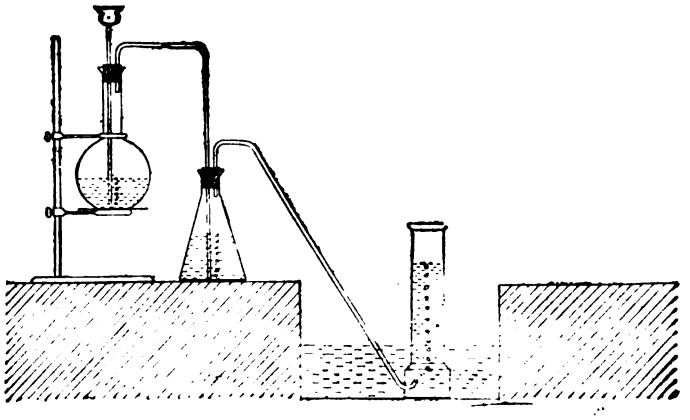

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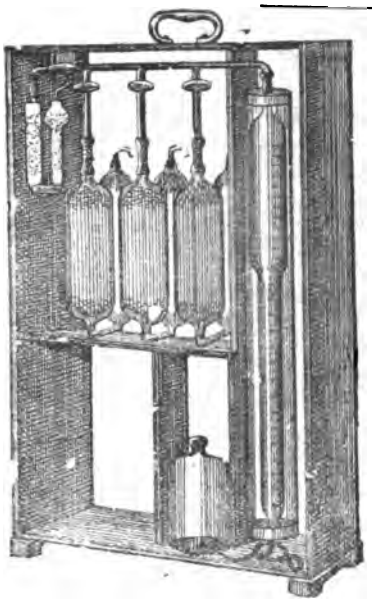

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